Electronic Design®

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VOL. 28 NO. 5

FOR ENGINEERS AND ENGINEERING MANAGERS — WORLDWIDE

MARCH 1, 1980

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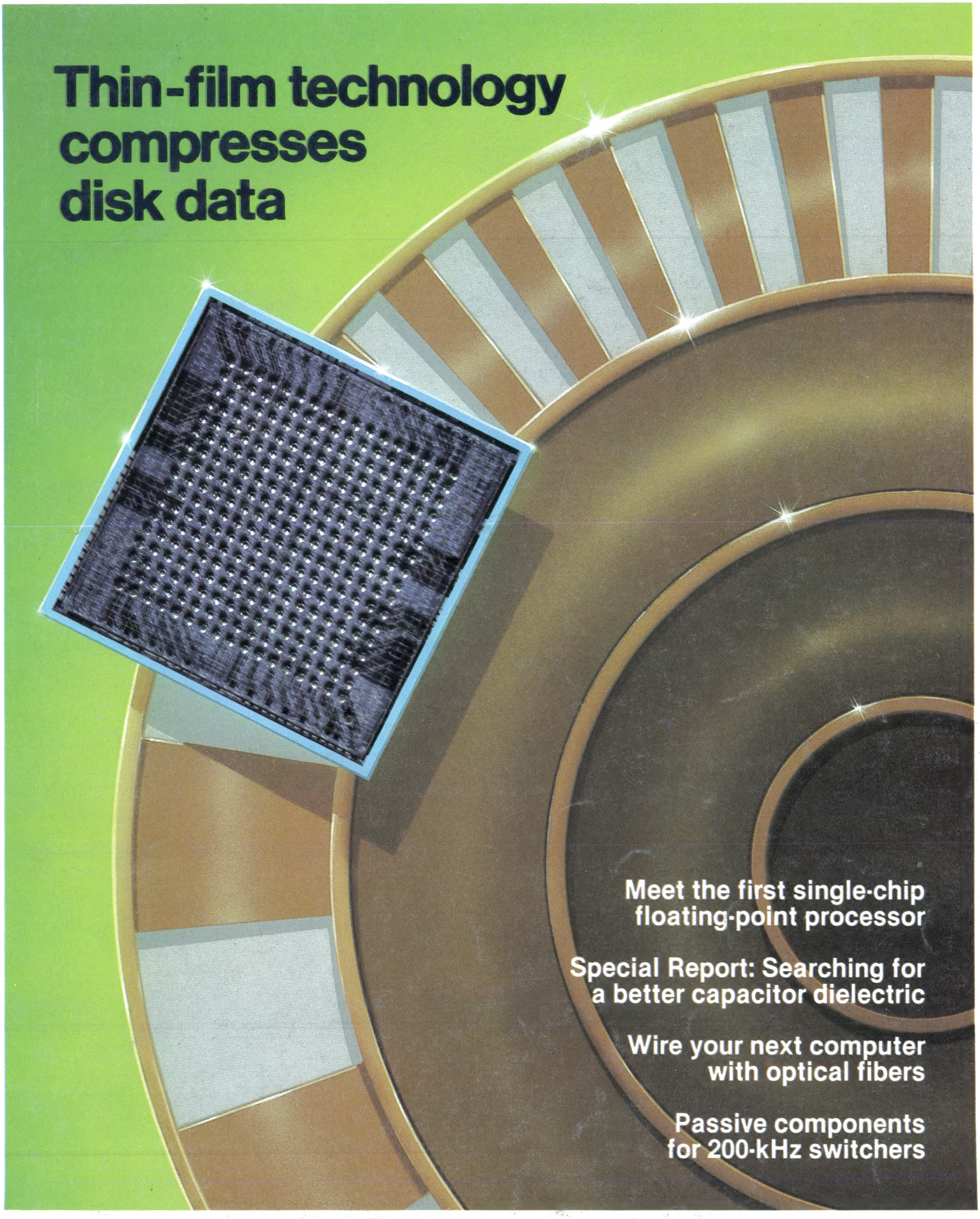

Thin-film technology compresses disk data

Meet the first single-chip floating-point processor

Special Report: Searching for a better capacitor dielectric

Wire your next computer with optical fibers

Passive components for 200-kHz switchers

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CIRCLE NUMBER 131

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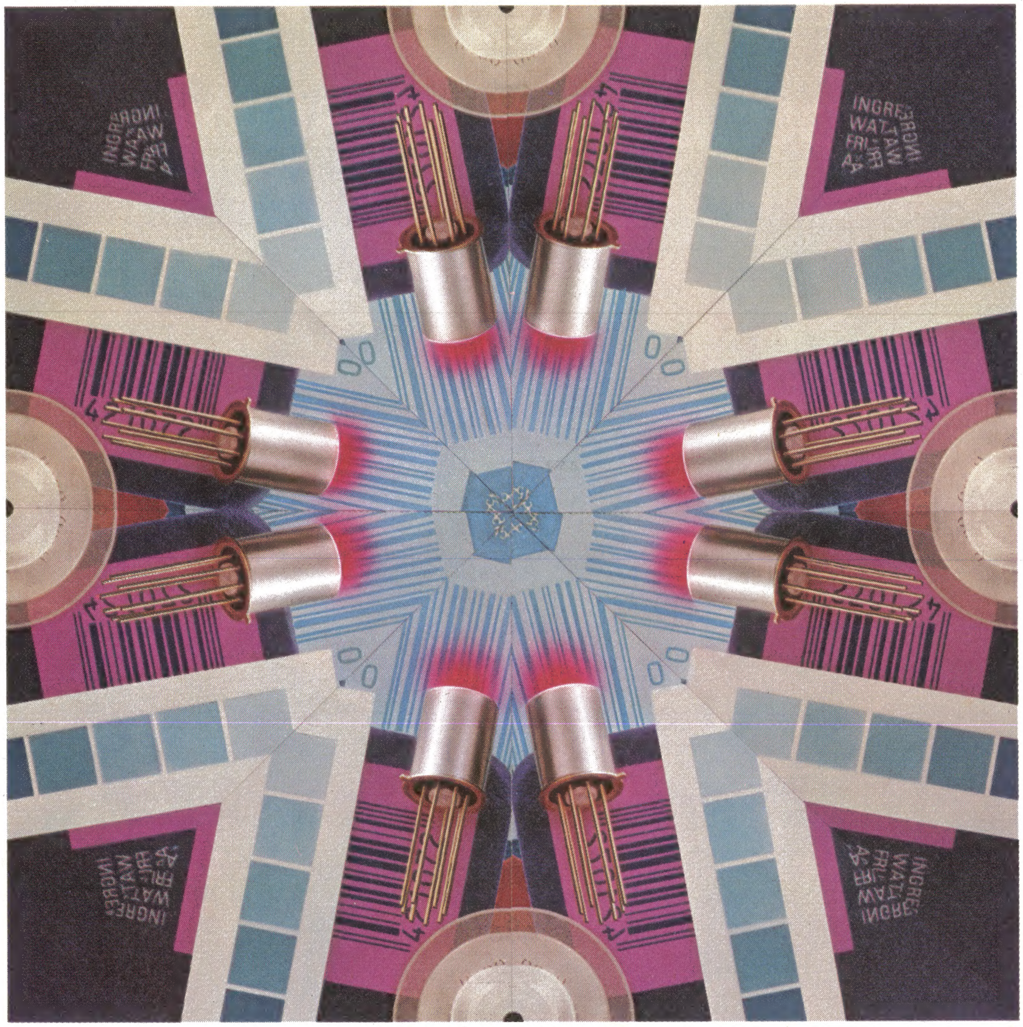

HP's New Optical Sensor Solves a Kaleidoscope of Problems.

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The HP HEDS-1000 combines an LED emitter, photo IC detector, and precision optics. The sensor module is fully integrated, so that no precision alignment tools, optical test equipment or special training are required for its use. It operates from a single 3.5 to 20V power supply and is priced at $18.50* in quantities of 100.

For more information or immediate off-the-shelf delivery, call any franchised HP Components Distributor.

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*U. S. Domestic Price Only

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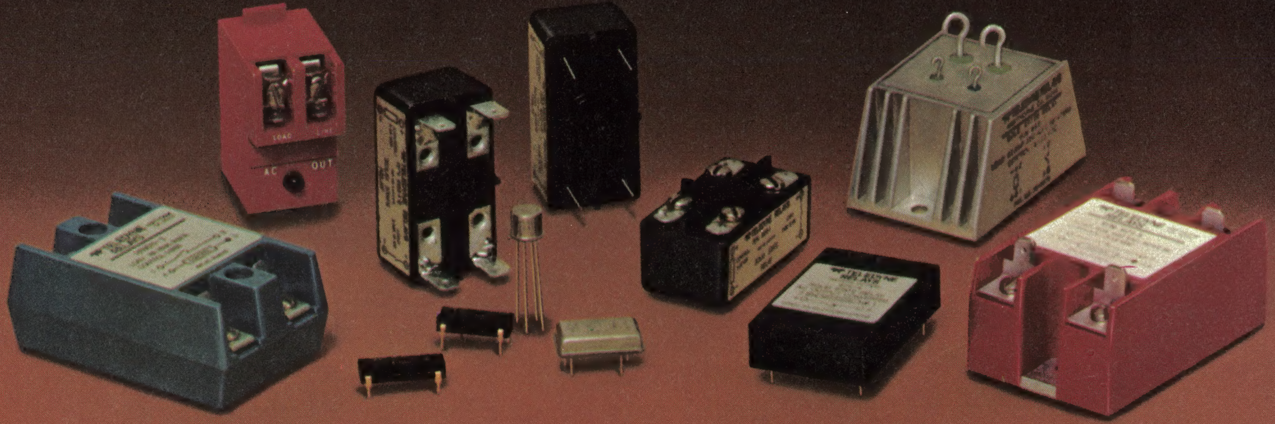
SSR UPDATE

AC Solid State Relays: We have more answers than you have questions.



Whatever your AC solid state relay switching problem, the odds are we have the answer sitting on our shelf. With more than 90 different models ready to meet your needs, you have to look long and hard to find a problem we can't answer.

The features tell the story. Voltage ratings up to 800V peak. Steady state load current ratings up to 40 Amps. High transient immunity. Optical isolation. Zero cross-over switching. A variety of packages for pc board, chassis or heat sink mounting. Even a family of military SSRs designed to meet MIL-R-28750. It's industry's most complete line of AC SSRs.

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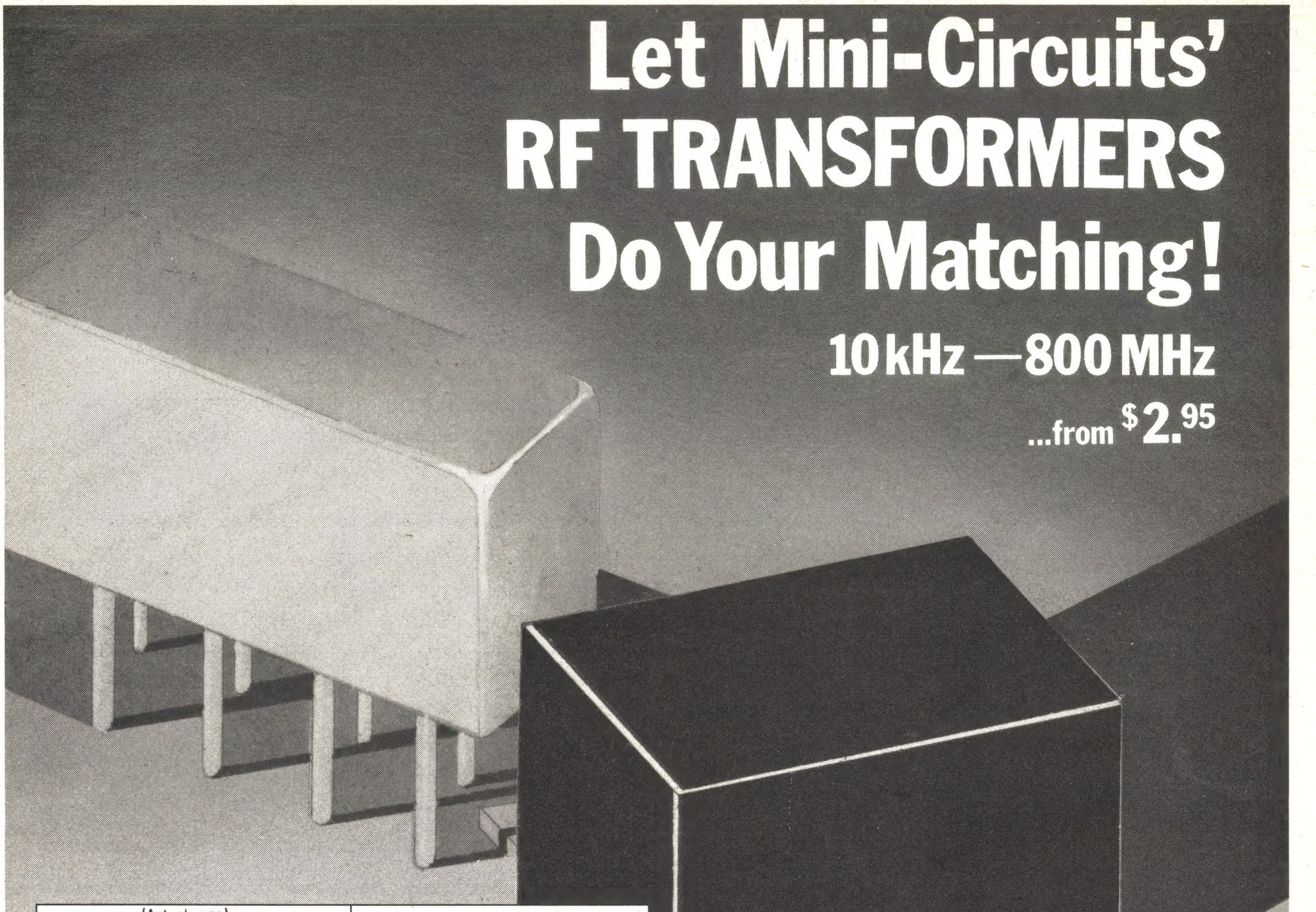

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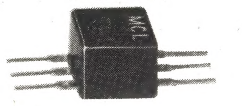
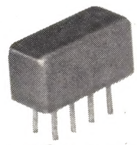


Models T, TH (Plastic case)
(0.300" sq. × 0.230" high)

(Actual size)



Model TMO (Metal case)
(.500" L × .230" W × .255" h)

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Model No.	Imped. ratio	Freq. (MHz)	Price (10-49)
T1-1	1	.15-400	$2.95
TMO1-1	1	.15-400	$4.95
● T1-1H	1	8-300	$4.95
T1.5-1	1.5	.1-300	$3.95
TMO1.5-1	1.5	.1-300	$6.75
T2.5-6	2.5	.01-100	$3.95
TMO2.5-6	2.5	.01-100	$6.45
T4-6	4	.02-200	$3.95
TMO4-6	4	.02-200	$6.45
T9-1	9	.15-200	$3.45
TMO9-1	9	.15-200	$6.45
● T9-1H	9	2-90	$5.45
T16-1	16	.3-120	$3.95
TMO16-1	16	.3-120	$6.45
● T16-1H	16	7-85	$5.95

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TMO1-1T	1	.05-200	$6.45
T2-1T	2	.07-200	$4.25
TMO2-1T	2	.07-200	$6.75
T2.5-6T	2.5	.01-100	$4.25
TMO2.5-6T	2.5	.01-100	$6.75
T3-1T	3	.05-250	$3.95
TMO3-1T	3	.05-250	$6.45
T4-1	4	.2-350	$2.95
TMO4-1	4	.2-350	$4.95
● T4-1H	4	8-350	$4.95
T5-1T	5	.3-300	$4.25
TMO5-1T	5	.3-300	$6.75
T13-1T	13	.3-120	$4.25
TMO13-1T	13	.3-120	$6.75

UNBALANCED PRIMARY & SECONDARY

Model No.	Imped. ratio	Freq. (MHz)	Price (10-49)
T2-1	2	.025-600	$3.45
TMO2-1	2	.025-600	$5.95
T3-1	3	.5-800	$4.25
TMO3-1	3	.5-800	$6.95
T4-2	4	.2-600	$3.45
TMO4-2	4	.2-600	$5.95
T8-1	8	.15-250	$3.45
TMO8-1	3	.15-250	$5.95
T14-1	14	.2-150	$4.25
TMO14-1	14	.2-150	$6.75

FOR ADDITIONAL INFORMATION, COMPLETE SPECIFICATIONS, AND PERFORMANCE CURVES, REFER TO 1979-80 MICROWAVES' PRODUCT DATA DIRECTORY pgs. 161 to 368 or 1979 EEM 2770 to 2974.

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CIRCLE NUMBER 4

Contents Spotlight

Interface 80: Communications designers meet the users
Worldwide, all-digital communications networks are destined to have a big impact on future data-communications equipment and system design. In view of the emerging technologies, all hardware, software and even personnel policies will have to be reexamined. It all starts at Interface 80, the data-communications professionals' conference of conferences, which always brings together users and designers in an instructive—and productive—atmosphere. Find out what top data-comm professionals consider the best ways to bring the future advances and developments to reality.

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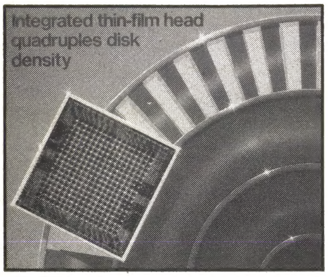

IBM 3370 has increased recording density built-in
Thin-film recording heads give the IBM 3370 magnetic-disk system twice the recording density of conventional disk systems. Because the heads are built in thin-film form directly on the slider assemblies in the drive, they fly closer to the disk, allowing higher fluxes to achieve the higher recording densities. The 3370 also adds an architecture that is the first of a new generation for handling the flow of information to and from the disk.

p. 60

Fiber optics puts EMI-proof links in computers
One of the major features of a fiber-optic communications link is its immunity to electromagnetic interference. For this reason, such links have already been put to use in military and telecommunications applications. But only now are they being used to interconnect commercial computer subsystems—and they can use the links. Not only are fiber-optic connections smaller in diameter and easier to route than their coaxial counterparts, they also can handle higher data rates over longer stretches.

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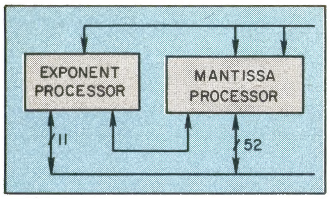

Floating-point chip slaves away for NS16000 family
Microprocessor designs often get compromised when all the functions are squeezed onto a single chip. A slave processor, the NS16081 floating-point slave for the NS16000 family, offers flexibility and performance enhancements to any bus-oriented processor. The architecture of the NS16000 microprocessor takes full advantage of the slave concept—and the N16081 returns the favor by performing a 32-bit floating-point multiply or divide in well under 10 μs.

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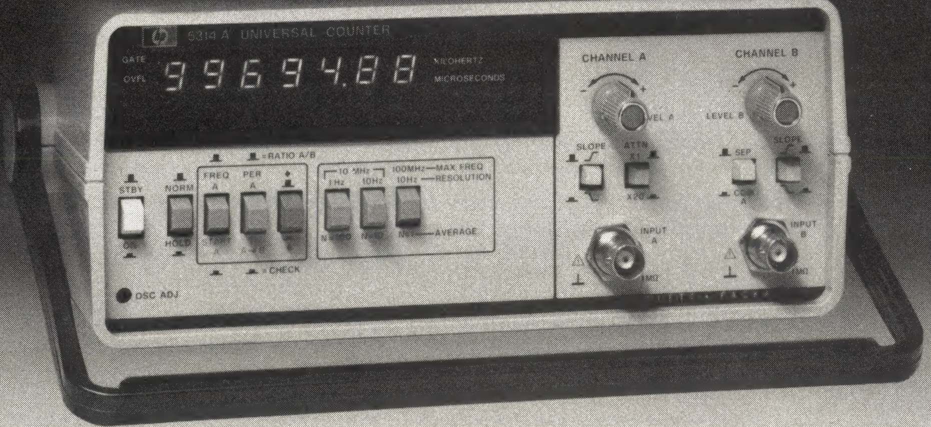
Once again HP makes your money count.



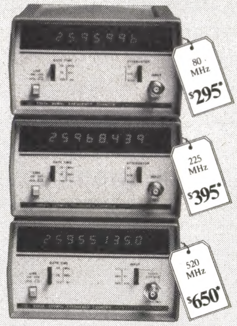
A universal counter for $375.

The smart money's on HP's new 5314A Universal Counter because it does so much for so little. Now, in one low-cost counter, you can measure frequency up to 100 MHz, period down to 400 nanoseconds with 100 picosecond resolution, and time interval with 100 ns resolution. Add frequency ratio, ratio averaging, totalizing and a full complement of time interval measurement controls and you've got a package you'd expect to find at almost twice the 5314A's $375 price. Options: internal battery and charger, $95; TCXO time base, $100.

Time interval measurement capabilities are truly outstanding at the 5314A's price. Instead of limited single channel controls, or none at all, the 5314A gives you both input trigger level and slope controls for two input channels. So now you can measure pulse widths or time between pulses with stop and start commands from either one or two input control lines.

HP's frequency counters also save you time *and* money.

Using state-of-the-art components common to HP's most sophisticated counters, the HP5380 frequency counter series offers high accuracy, high input sensitivity, input attenuators and direct counting for rapid, convenient frequency measurement and adjustments.
5381A 80 MHz, $295 • 5382A 225MHz, $395 • 5383A 520 MHz, $650.



To find out more about HP's low-cost laboratory grade counters and the entire family of sophisticated and versatile HP counters call your nearest HP field office. Or write for the 5314A and 5380 series data sheets and electronic counter brochure to Hewlett Packard, 1507 Page Mill Road,
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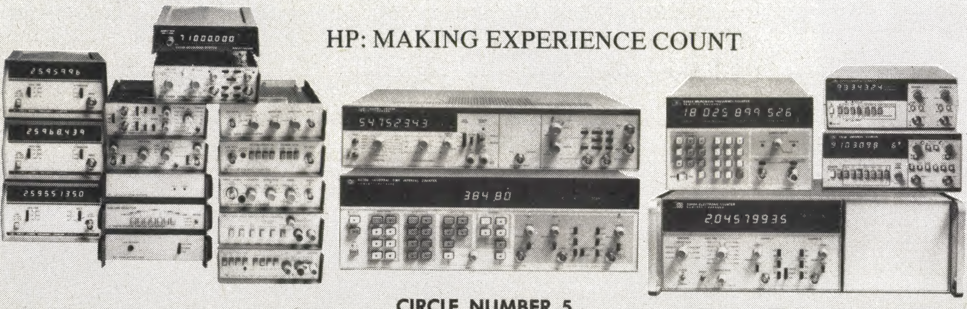
HP: MAKING EXPERIENCE COUNT



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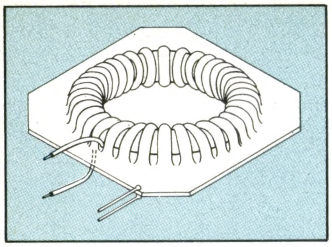

Passive components—the key to high-frequency switchers
Building high-frequency switching supplies hinges on knowing how to handle capacitive and magnetic components. The ground rules for selecting capacitors and designing transformers and chokes at 200 kHz are far different than at 20 kHz. Pulse-width-modulator ICs present another problem at high frequency—there are just a few chips that can do the job.

p. 87

8086 μP's architecture handles high-level language efficiently
Since programs written in a high-level language use more memory than programs written in assembly language, designers often face a dilemma—ease of programming vs extra costs for memory. But memory requirements of the PL/M-86 compiler for the 8086 16-bit μP are less than 1.5 times those of the corresponding assembler. The key to this savings is the 8086's architecture, which uses the optimum number of registers to implement the HLL efficiently.

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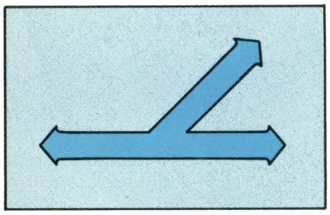

Controller augments the powers of bubble memories
A bubble-memory controller can extend a system's capacity along any one or combination of three axes. When expansion is along three axes together, capacity soars to more than 512 Mbytes, and data transfers speed up to 16 Mbytes/s. The controller handles the interface to the host, timing signals, data transfers (optional) and the data corrector/formatter in Texas Instruments' Bubble Modular Array with Correction.

p. 103

Focus on Capacitors
The new darlings of the microprocessor world, reduced titanate ceramics, are a top choice for high-speed, small-signal filtering, but are frequently vulnerable to temperature and humidity without specialized packaging. Tantalum oxides, providing the highest capacitance and best stability in small packages, are becoming prohibitive in cost. Ultrastable polyester films can be one oversized alternative; low-cost aluminum electrolytics claim to be another. Making the best choice among advanced capacitor dielectrics is not easy, but this exclusive product showcase helps point the way.

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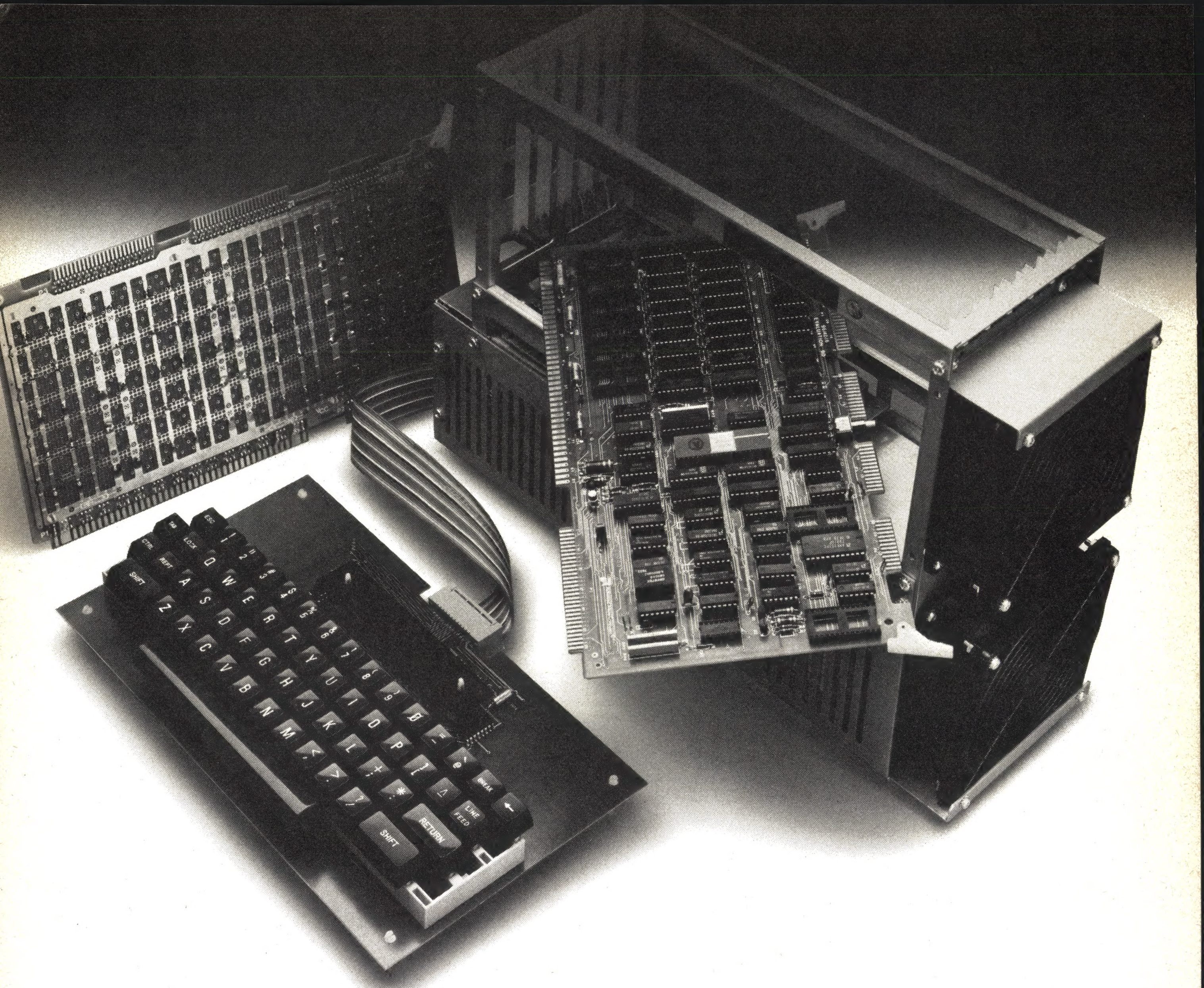
Electronic Design 6

Featured Next Issue

In the March 15 issue:

Microcomputer Data Manual and Design Guide . . . FEATURING: An update on single-board microcomputers and a Focus Report on analog-I/O boards . . . Board-selection tables, and hardware and software-design guides . . . Operating-system pullout chart . . . PLUS: A 16-bit μP operating system.



The AmZ8000 is better. And we can prove it.

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Use the Am96/4016 to execute AmZ8000 software at 4MHz. Use its monitor software program for register inspection, reading and changing of memory location, and debugging. Use the optional line-by-line assembler for writing the critical programs you need to prove the feasibility of your system design.

If you want to check out your specific design applications by adding other components, our Am96/6410 board is for you. If you need to add more RAM, the AM96/1064 lets you add up to 64K bytes. If you want a hard copy of your results, just connect the Am96/4016 to a serial or parallel printer.

The Am96/4016 has an optional, low-cost ASCII keyboard/display, so you can use it all by itself. Or use it with your own CRT. Or with our AmSYS8/8 Z8000 Development System.

But most of all, use it to prove once and for all that the AmZ8000 is the best 16-bit family for you.

Standard Features:

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CIRCLE NUMBER 7

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Sensitive traffic lights

Comments in the Jan. 4 Reader Feedback regarding your "Hydrogeneering?" editorial (Oct. 25, 1979, p. 41) have provoked me into sending in my 15 cents' worth.

It appears to me that one reason so many people do not believe there is a real energy shortage is that the powers-that-be ignore some of the most obvious ways of making tremendous savings. For instance: If all traffic lights were made traffic sensitive, so that vehicles would not have to wait at red when there was nothing coming the other way, more energy could be saved daily than most of the proposed government-agency programs put together. This would not even require microcomputers, just simple sensors and logic circuits that have been around for a long time.

An even lower-cost interim modification would save hundreds of gallons of motor fuel daily in any and every small city in the country: putting multiple timers on traffic lights, so that the timing is changed according to the time of day and the corresponding change in traffic patterns.

From what I read elsewhere, there are many sources of energy that will become available as soon as the price of petroleum makes them economical. Certainly, engineering and technological innovation will help hold down the cost of alternative sources, such as shale and coal conversion and hydrogen production, as soon as there is any large-scale and competitive activity in these fields. Energy is a commodity whose price should be determined by a free market. Uncle Sam should quit price fixing, subsidies and other wastes. As an enormous energy savings for the taxpayer, we could do without about 95% of the DOE budget.

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A dissatisfied customer

I would like to describe my experiences with a manufacturer that advertises in your periodical as "time-proved, rugged and reliable."

We chose the manufacturer because of our belief in its advertisements, the availability of local service, the satisfaction of customers we knew and our visual inspection of the hardware. We bought between $15,000 and $20,000 worth of equipment.

We have had problems with five different types of boards, with the most problems cropping up in the PROM boards. To fill our order of six operational boards, we tested ten boards. We found four boards good, two boards heat-sensitive and repairable, and four boards not worth the effort to repair. The bad ones varied from one that burned backplane traces to one that didn't have its Augat jumper sockets loaded. Most of the problems appeared the first time we tried to use the boards. All the problems exhibited themselves within the first 24 hours of actual use.

Having talked to enough other customers to conclude our experiences were not unique, it is my opinion that this company does not design a rugged product and does not perform the qual-

(continued on page 14)

Electronic Design welcomes the opinions of its readers on the issues raised in the magazine's editorial columns. Address letters to Editor, Electronic Design, 50 Essex St., Rochelle Park, NJ 07662. Try to keep letters under 200 words. Letters must be signed. Names will be withheld upon request.

LOW COST
HIGH RELIABILITY
REFLECTIVE OBJECT
SENSORS

New, low cost TRW Optron solid-state reflective object sensors offer high reliability for non-contact sensing applications.

TRW Optron's new high reliability OPB 708 and OPB 709 reflective object sensors provide excellent performance for non-contact sensing applications at an inexpensive price.

The OPB 708 is a plug-in replacement for the TIL139 reflective object sensor.

The new TRW Optron devices combine a high efficiency solution grown gallium arsenide infrared LED with a silicon N-P-N phototransistor (OPB 708) or maximum sensitivity photodarlington (OPB 709) in a molded plastic package. The photosensor senses radiation from the LED only when a reflective object is within its field of view.

With a LED current of 40 mA and with the OPB 708 positioned 0.150 inch from a reflective surface, typical output current is 50 μA for a 90% diffuse reflective surface and 1.0 mA for a specular reflective surface such as aluminum foil. Under similar operating conditions, the output current of the OPB 709 is 7.5 mA and 100 mA.

Both devices are ideally suited for such non-contact sensing applications as paper or card edge detection, motor speed controls, EOT/BOT sensing, and proximity detection.

The OPB 708 and OPB 709 as well as other low cost, high reliability reflective object sensors are immediately available from stock. Custom versions are available on request.

Detailed technical information on the OPB 708 and OPB 709 reflective object sensors and other TRW Optron optoelectronic products . . . chips, discrete components, optically coupled isolators, and interrupter assemblies . . . is available from your nearest TRW Optron sales representative or the factory direct.

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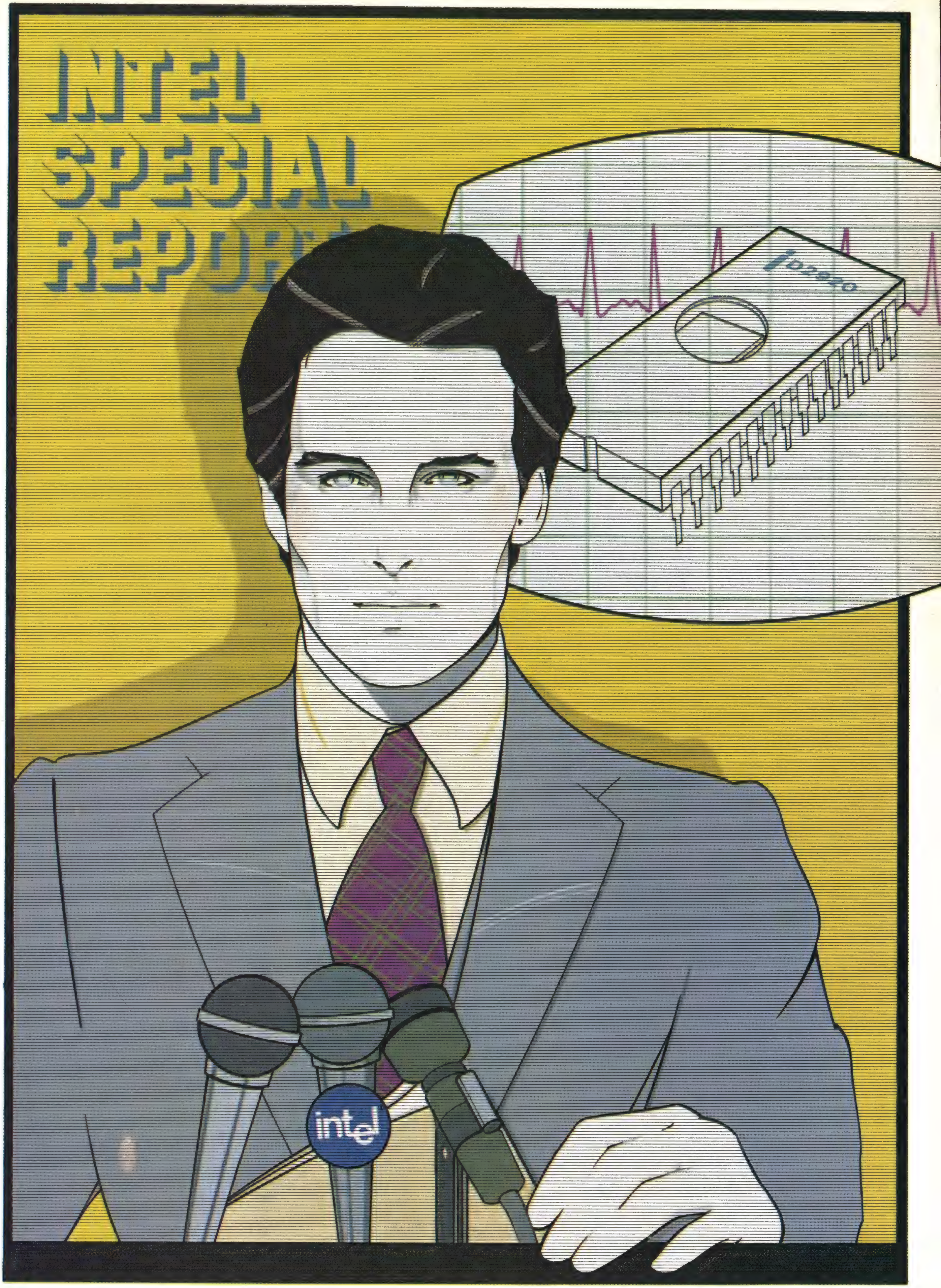
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LSI Breakthrough for Analog

Intel announces the 2920 Signal Processor, first general purpose, real-time system on a chip.

Good news for analog designers. Intel breaks a new barrier in microelectronics: The first intelligent chip powerful enough to process analog signals in real time. Plus a computer-aided development package to help speed your systems to market faster than ever before.

Intel's 2920 is a complete, micro-sized signal processing system that packs the equivalent of over 18,000 transistors on a single chip. It operates hundreds of times faster than current digital processors. And best of all, the 2920 allows designers to *program* system values quickly, instead of having to match and tweak components.

A revolution in analog design

From the beginning, LSI technology has helped designers achieve dramatic improvements in product size, design cycles and manufacturing economics. But until now, the speed and complexity of analog processing has stood in the way of general purpose, single chip solutions for real-time applications.

Today, Intel's 2920 Signal Processor brings the power and flexibility of LSI to the analog world. Because of its size, the 2920 can fit in spaces too compact for traditional analog solutions. Because the 2920 is programmable, product development and time-to-market are speeded significantly. Finally, because the 2920 is a solid state device produced with Intel's proven NMOS process, reliability and manufacturing repeatability are assured to a degree not possible with previous methods.

Micro-processing for the real world

Applications for the 2920 are as broad as your imagination. Since analog designers can program the 2920 processor to perform a large number of standard building block functions, the chip can be used as an entire subsystem. Implement such functions as complex filtering, waveform generation, modulation/demodulation, adaptive processing, and even non-linear functions. This broad capability makes the 2920 an ideal single chip solution for virtually any application in the DC to 10 kHz range.

And like the digital microprocessor, the 2920 is destined to create entirely new classes of applications: products that are smaller, simpler, and less costly to produce. It gives a competitive advantage to companies in such areas as process control, test and instrumentation, guidance or control systems, telecommunications, speech processing, and seismic or sonar signal processing.

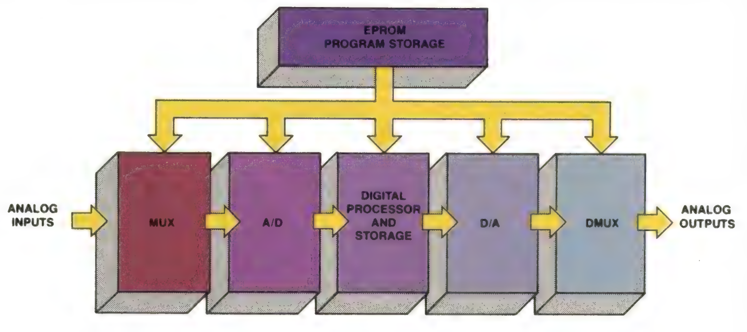
How the 2920 simplifies system development

Programming Intel's 2920 Signal Processor is fast and easy to learn—far less complex than the component matching it replaces. Most importantly, Intel provides the complete support tools and design workshops you need to start designing 2920 systems today.

Our SP20 Support Package and Intel's Intellec® Microcomputer Development System allow you to develop and debug by simulating your system in software. Just program functions according to your system schematic, then specify input and operating values. Together, Intel's development aids let you see how your system will work before you even build a prototype. Best of all, because you develop in digital code, your prototype system will be duplicated precisely in manufacturing.

Start making news with your product

Everything you need to begin designing a new generation of real-time analog processing systems is here today: Intel's 2920 Signal Processor, SP20 Support Package, and the Intellec Development System. For detailed information, including our new 2920 brochure, plus a schedule of Intel's nationwide 2920 Design Workshops and Seminars, contact your local Intel sales office or distributor. Or write Intel Corporation, Literature Department, 3065 Bowers Avenue, Santa Clara, CA 95051. Or call (408) 987-8080.



Functional Block Diagram of the 2920 Signal Processor

intel® delivers.

Europe: Intel International, Brussels, Belgium. Japan: Intel Japan, Tokyo. United States and Canadian distributors: Arrow Electronics, Alliance, Almac/Stroum, Component Specialties, Cramer, Hamilton/Avnet, Harvey, Industrial Components, Pioneer, Wyle/Elmar, Wyle/Liberty, L.A. Varah and Zentronics.

CIRCLE NUMBER 9

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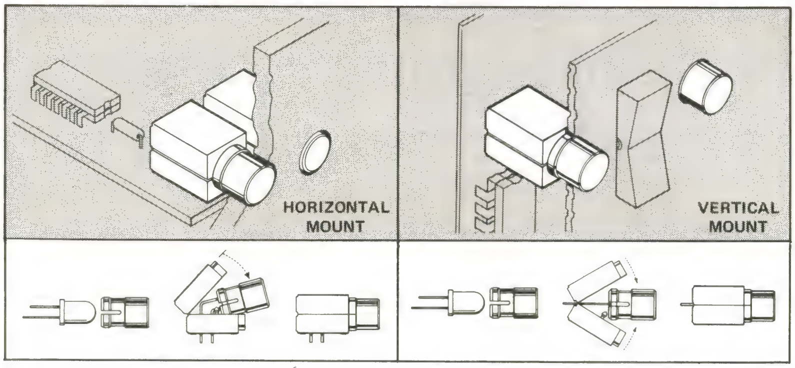

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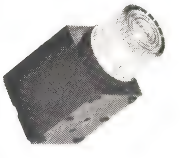

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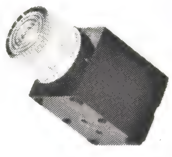

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CIRCLE NUMBER 10

Reader Feedback

(continued from page 11)

ity assurance necessary to ship a reliable product.

The journals and periodicals must realize that they have a responsibility to their readership, before their advertisers. If an ad is false, or even misleading, it should not be accepted. If the ad makes statements, the publishing of the ad implies that those statements have been proven to the satisfaction of the editors.

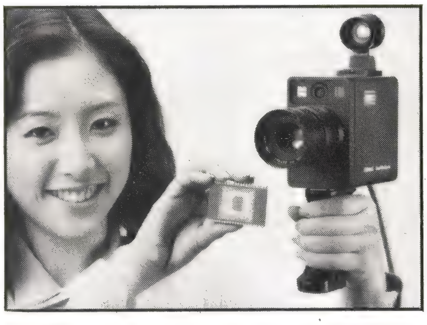
In addition, the customer must have a forum in which manufacturers are discussed. As a service to the industry, this forum should be provided through the journals and periodicals. This could only help the manufacturer that really wants to sell "rugged and reliable" equipment.

John Harpootlian

Box 2641
Menlo Park, CA 94025

Ed Note: Our policy regarding advertising is, of course, to refuse any advertisement deemed to be misleading or fraudulent (see p. 155). However, we cannot verify qualitative claims like "time-proved, rugged and reliable." We have passed your letter on to the manufacturer in question.

A little bigger than you thought



If anyone reading our article on the Matsushita solid-state color TV camera (Jan. 18, 1980, p. 23) was wondering how they managed to make the camera look like a pair of tweezers on a PC board, stop wondering. At the last minute, our printer switched photos on us. The one that appeared was the E-Z Circuit line of PC board fabrication components from Bishop Graphics (Westlake Village, CA), which was subsequently covered in our Feb. 15 issue, p. 180. Here's the photo that should have run.

Success is a journey. Not a destination.

—Ben Sweetland

Success. For us, it's a continuous, cumulative process of individual achievement.

It's individuals who develop our new technology. Refine our manufacturing techniques. Invent our new products. Anticipate our future markets. And if they stop, we stop.

That's why we spend so much time encouraging individual achievement. Why we recognize and reward personal success. Why we so firmly believe in nurturing new ideas, no matter how radical they may seem at first glance.

As our people gain confidence in their individual ability to succeed, we succeed. We can set higher goals. And we can be confiden that our people will continue to surpass them.

Individual success work at Mostek. It has made us the world's leading supplier of dynamic RAMs. A respected innovator in microcom- puters and systems. A pioneer in telecommunication technology. And has led to clear dominance of the telecommunications market with the broadest product line available.

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CIRCLE NUMBER 11

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370 microcomputer
signed specifically for controller applications. It's the easiest to use, most flexible microcomputer on the market today, and requires less software to do many more jobs.

The multiple-source F3870 gives you up to 4K bytes of ROM in 8-bit words. Its programmable timer, the best available today, operates in three modes (event counter, interval timer or pulse width timer). The many other features, and the forthcoming EPROM version (F38E70), make this the ideal controller

stay there.

Fairchild also features a broad line of LED and LCD products. Including LED lamps and digits, and new very-large-area LCDs which are fully hermetic, and operate over a wide temperature range. Plus, Fairchild's LCDs offer complete freedom in styling, formats, colors and symbols.

Fairchild also has non-volatile memories to ensure that your dishwashers and washing machines re-cycle correctly after power outs, without batteries.

Taking control of the appliance market is going to take time. Fairchild has the semiconductor components and engineering support to help you take control. The time is now. For more information, call your nearest Fairchild office.

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FAIRCHILD

CIRCLE NUMBER 151

Improve your memory with AVX multilayers

AVX multilayer ceramic capacitors are the perfect choice for decoupling today's greater density memory applications.

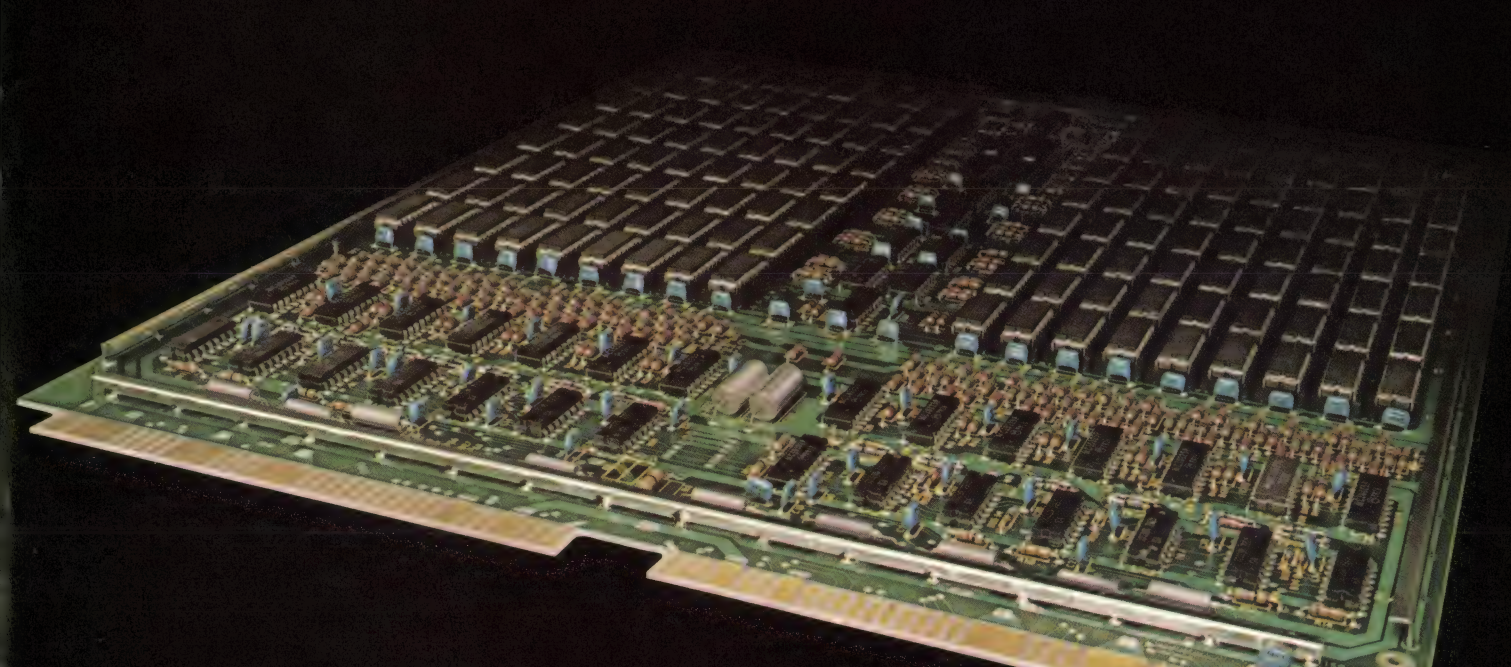
Newer high-speed dynamic RAM's, with faster edge rates require capacitors with lower impedance at high frequency to eliminate transient currents. This places a greater emphasis on the capacitor inductance and less emphasis on the bulk, board-level decoupling as in previous designs.

As a result, these conditions favor the use of MLC's in place of tantalum capacitors for the full range of decoupling needs.

Contact AVX today for more information on replacing tantalum with superior performance axial, radial and 2-pin DIP multilayer ceramics. Write to AVX Ceramics, Dept T-80, P.O. Box 867, Myrtle Beach, SC 29577.

AVX. We'll help you improve your memory.

AVX CERAMICS
Technology for the times



CIRCLE NUMBER 13

Thinking modems?

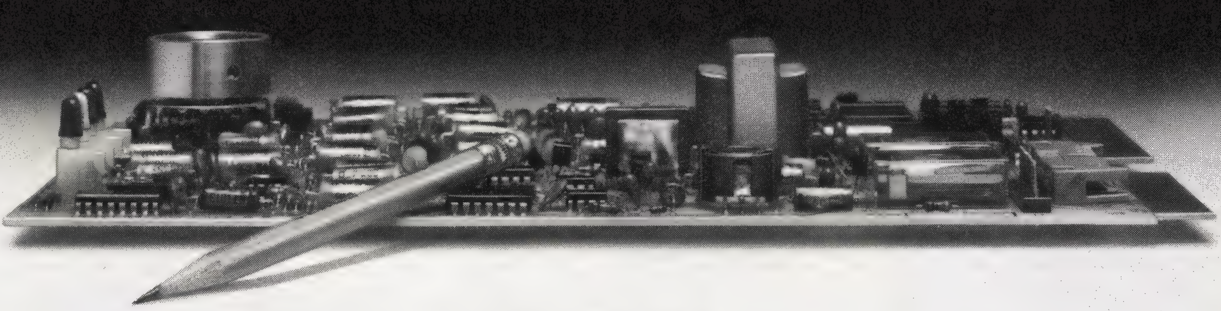
Think Intertel OEModems.

For over ten years, Intertel has been designing modems for the nation's largest data processing equipment manufacturers. Responding to the high performance needs of companies like Bunker Ramo, Data General, and TRW.

With a record of unmatched performance in the medium to high-speed range (1200 to 9600 bps), Intertel stands ready to meet your advanced modem requirements. Custom or standard, stand-alone or rack-mounted, you can add Intertel OEModem dependability to your application. They're priced right, delivered on time, and designed to fit your needs.

So if you're thinking modems, think Intertel OEModems—the creative solution you've been looking for.

Write for our descriptive literature . . . or call Tony Rotondo now for details. Intertel, Inc., 6 Vine Brook Park, Burlington, MA 01803. (617) 273-0950.



intertel

CIRCLE NUMBER 14

Coprocessor cooperates with 8 or 16-bit μPs

When a microprocessor system must perform specialized tasks, the standard tactic is to add slave circuits—but now, for help in extending its processing capability, the microprocessor system can turn to a coprocessor. The coprocessor, Intel's 8087, is a numeric data processor circuit (NDP) that broadens the register resources and instruction set of the base processor.

As described by Intel Corp. (Santa Clara, CA) at the ISSCC conference in San Francisco, an NDP mates with either an 8 or a 16-bit μP; and the two processors interpret the same instruction stream. In response to a set of commands called ESCAPE operations, the μP calculates the data address when it is a memory instruction, and puts the address on the bus. The NDP then latches the address and reads the data from memory.

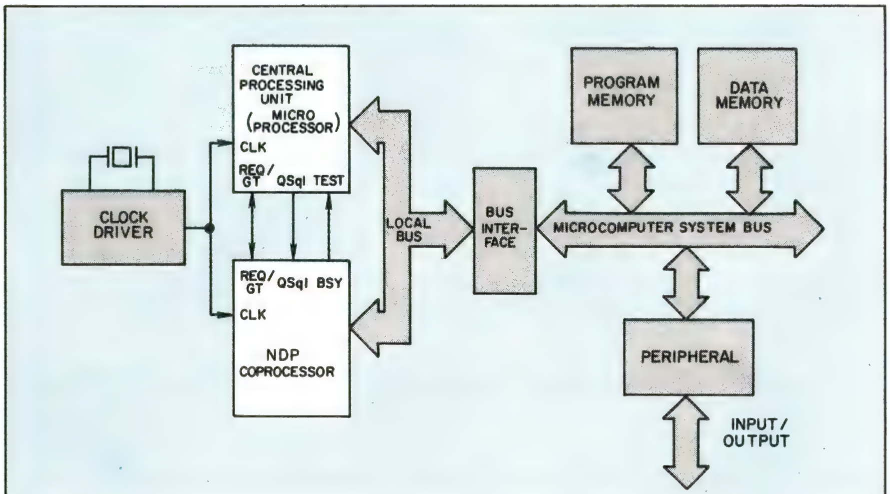
First, the NDP reads the operand, then it performs the operation contained in the ESCAPE instruction and releases the bus to the microprocessor. Thus, the processor can continue working on nonnumeric instructions, rather than waiting for the coprocessor to finish its tasks.

Capable of operating on seven types of data, the NDP handles 16, 32 and 64-bit two's complement integers; 32-bit (REAL), 64-bit (LONG; REAL), 80-bit (TEMPORARY REAL) binary floating-point numbers; and 80-bit (18-digit) signed packed BCD integers. Operations performed by the NDP include add, subtract, multiply, divide, remainder, square root, transcendental functions and binary/decimal conversions.

To make a chip with the NDP's number crunching ability, Intel developed a four-state ROM implemented in HMOS. The device fits more than 30,000 bits of ROM on-board, as well as 700 bits of RAM, a 68-bit arithmetic and logic unit, a fast shifter (0 to 63 places in one clock-time) and a 68-bit-wide data path for high throughput. In all, the NDP contains the equivalent of more than 65,000 devices.

Internally, the circuit contains two subsystems—a bus interface section and a floating-point execution unit. The multiply, divide, square root and remainder operations are contained in a hardware arithmetic module controlled by microcode. The data path uses synchronous access and is precharged for easy interfacing to different sources.

Additional circuitry includes special hardware to count leading zeros and a hardware subsection to implement the various rounding modes specified by the proposed IEEE floating-point standard.



Capable of coprocessing with either 8 or 16-bit μPs. Intel's numeric data processor (NDP) extends the resources of the base μP.

Fast DAC re-creates 0-V data accurately

Audio, acoustic and sonar signals contain substantial information in the vicinity of "zero volts" or mid-range. To accurately re-create these waveforms from digital data requires a d/a converter with exceptional small-signal performance and no crossover distortion near the zero level.

Analogic (Wakefield, MA) has developed a modular 16-bit audio DAC, the MP1926, with a unique sign/magnitude architecture for processing data near 0 V.

At 0-V levels, the device boasts 18-bit linearity and settles to 0.01% of a 5-V step, in under 3 μs. Slower competitive converters offer, at best, 14-bit accuracy at mid-range—and at higher prices.

Linearity for the MP1929 is better than ±1/4 LSB (4 ppm) near 0 V. The full-range harmonic distortion, measured with a forthcoming deglitch amplifier at the output, is better than 0.005%, or 0.0005 dB.

HEXFETs take on chip form

First they came in TO-3, then in plastic TO-220AB packages. Finally, the HEXFET devices from International Rectifier (El Segundo, CA) will be available as dice, with on-resistance tested and guaranteed—at a drain current of 1 A.

The 90 × 138-mil HEXFET 2, to be ready in April, has one gate and one source bonding pad for connection. It will be followed by HEXFET-3 (114 × 180) and HEXFET-5 (250 × 250). All dice will be available in three voltage ranges: 100, 200 and 350-V.

Because the devices are dice, which must be electrically probed, some specs of the equivalent packaged transistor cannot be guaranteed—notably, power dissipation and safe operating area. In addition, the only problem with an on-resistance spec is that the final value depends on the customer's care and skill in mounting the die.

HEXFET power chips will not be available through any distributors—all orders are through the company.

Photosensors lift interface burden

Optical couplers no longer require help from several additional packages when the coupler's phototransistor output must mate to a TTL input: The OPL550 photosensor can drive up to eight TTL loads directly. No other signal processing circuitry is needed. The discrete, individually-packaged photosensor comes in a buffer configuration with a totem-pole output, from TRW Optron, Inc. (Carrollton, TX).

The new device is one member of a family called Photologic, which will eventually include other discrete building blocks, as well as complete optoelectronic couplers. All sensor elements in the family will be either buffers or inverters. Both buffers and inverters can have either totem-pole or open-collector outputs. When complete, the photologic family will comprise 14 different photosensors in four different packages.

Photologic chips are monolithic integrated circuits which include a photodiode, a linear amplifier and a Schmitt trigger. A chip is encapsulated in a molded plastic package for optical coupling to a compatible infrared emitting diode, such as the TRW Optron OP-140.

In a complete coupler, a 550 sensor chip is combined with a LED emitter in a suitable housing. Two complete couplers are now available from TRW Optron: the OPL800W, a totem-pole buffer in a three-lead can with a transparent lens top, and OPB913S10, a totem-pole buffer in an interrupter-type package, with a gap in the middle. However, the series is designed so that users can purchase either complete packages or photosensors alone.

Briefs

The first monolithic 14-bit digital-to-analog converter is on the way from Hybrid Systems (Bedford, MA). Besides offering 14-bit resolution and accuracy, the custom CMOS chip is a four quadrant multiplying device with on-board buffers and decoders. Settling for current outputs will take just 1 μs. Power dissipation will be less than 50 mW, and temperature stability will be about 2 ppm/°C.

New features for building and managing distributed-processing networks will be available with the Phase III family of DECnet products from Digital Equipment Corp. (Maynard, MA). Called DECnet-11M Plus, DECnet-11M and DECnet-11S, the software modules, protocols and support services for use with PDP-11 computers offer such innovative capabilities as automatic message routing between nonadjacent nodes, command-terminal access to remote systems and communications support for remote lines.

High-gain signal-conditioning modules are available in two new data-acquisition components from Analog Devices (Norwood, MA). The 2B54 processes four separate inputs from thermocouple junctions and other small signal transducers in the ±5 to ±100-mV region. The 2B55 module processes signals from 50 mV to 5 V. Both models provide channel-to-ground and channel-to-channel isolation of 1000 V dc. Intended to replace flying-capacitor circuits in data-acquisition systems, the analog modules can scan at up to 400 channels per second.

A 12-bit monolithic DAC that resolves better than ±1/2 LSB in less than 300 ns is coming from Teledyne Philbrick (Dedham, MA). The 4068 comes in a hermetically sealed 24-pin DIP that ensures low offset drift (less than ±2 ppm/°C) and low gain drift (±10 ppm/°C) over 0 to 70 C. Current outputs can be programmed for bipolar or unipolar signals.

Updated Data Translation intelligent analog peripheral systems feature high input isolation and wide dynamic range. The single-board IAP systems are 8085A-based and compatible with the Natick, MA company's Multibus backplane. Up to ±250 V of common-mode voltage can be rejected while measuring differential signals as low as 20 mV.

A new series of powerful medium-speed and Schottky power rectifier diodes to be announced by Unitrode (Lexington, MA) provides the same power as the company's premium-grade UES series, but at a somewhat slower speed and lower cost. The SES-series devices offer current ratings ranging from 2 to 60 A and are available in all popular case styles—DO-5, TO-3, TO-4 and TO-220.

The SineTrac ST-724 analog-I/O board is electrically, mechanically and pinout-compatible with Intel's SBC microcomputer boards for half the price. Developed by Datel-Intersil (Mansfield, MA), the $595 board packs 4 to 20-mA current-loop amplifiers and a dc/dc converter. Four on-board d/a channels offer 12-bit resolution and 0.05% FSR accuracy.

An 8-bit DAC will speed up the interface between data-bus and analog output. The AD558 from Analog Devices (Norwood, MA) is one of the first monolithic DACs not only to include references and high-speed logic gates but also to function from a single supply. Introduced at this year's ISSCC, the 558 will function on any single supply voltage in the range of ±4.5 to ±16.5 V, resolve ±1/2 LSB in 700 ns, and interface with TTL or CMOS signals as low as 100 μA.

Revolutionary HEXFET technology now in medium power MOSFETs.

Off-the-shelf delivery at down-to-earth prices!

The ratings of six smaller but no less brighter new stars in the ever-expanding HEXFET line are highlighted in the table below.

This advanced set of medium power transistors features a new die size created to provide HEXFET technology and the established MOSFET design advantages of voltage control, ease of paralleling, freedom from second breakdown and ultra-fast switching at record low costs.

For example, the 1000 piece price for the 100V IRF520 is only $5.95, and the 400V IRF720 is just $6.30. At such low prices, chances are these new TO-3 or TO-220AB HEXFETs can make MOSFET advantages affordable for your application.

We're not a bit starry-eyed about delivery. All HEXFETs listed in the table are available NOW . . . from us or from in-depth stock of an IR Distributor near you.

Contact us, an IR Sales Office or Rep for Tech Data, today. HEXFETs will do a stellar job for you tomorrow!

VOLTAGE RATING	TO-3 PACKAGE			TO-220 PACKAGE	
100	IRF120 7 Amps	IRF130 12 Amps	IRF150 28 Amps	IRF520 6 Amps	IRF530 10 Amps
200	IRF220 4 Amps	IRF230 7 Amps		IRF620 3.5 Amps	IRF630 6 Amps
400	IRF320 2.5 Amps	IRF330 4 Amps	IRF350 11 Amps	IRF720 2 Amps	IRF730 3.5 Amps
500		IRF430 3.5 Amps			IRF830 3 Amps

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I⊘R

CIRCLE NUMBER 15

Now! QPL-certified KEMET® tantalums at easy-to-take commercial prices!

Here's another KEMET first! Dipped and Molded Solid Tantalum Capacitors are now available to meet the full requirements of MIL-C-49137. KEMET is the first to offer non-hermetically sealed solid tantalum capacitors which meet total QPL requirements!

Now you can meet MIL-spec requirements without spending time and dollars to have a custom capacitor produced and tested. Just specify KEMET caps!

The new QPL-grade solid tantalums are available at realistic prices, too. Now you can put extra reliability into your present commercial equipment simply by upgrading to new KEMET QPL-certified parts.

KEMET® SERIES	CV RANGE*	OPERATING TEMP. RANGE	CASE SIZES AVAILABLE
T323	0.15 to 68.0 μF, 2 to 50V	-55 to +85°C	A,B,C,D
T363	0.1 to 330.0 μF, 6 to 50V	-55 to +85°C	A,B,C,D
T369	0.1 to 330.0 μF, 6 to 50V	-55 to +85°C	A,B

*25° at 120 Hz

Select the new KEMET QPL capacitors you need—for coupling or decoupling, blocking, by-passing and filtering in computers, in telemetry and data processing systems, communications, instrumentation and other high-reliability electronic circuits.

Select axial or radial leaded cases, suitable for manual or high-speed machine insertion in your circuit boards. T323 units can even be supplied in bulk packaging or lead-taped on reels for use in automatic insertion equipment.

KEMET Solid Tantalum QPL-certified Capacitors. Another step forward from the Electronics Division, Union Carbide Corporation, P.O. Box 5928, Greenville, SC 29606. Phone: (803) 963-6300. TWX: 810-287-2536; Telex: 57-0496. Or see your local KEMET Representative.

KEMET OFFERS YOU MORE.

See EEM for KEMET Capacitors General Catalog

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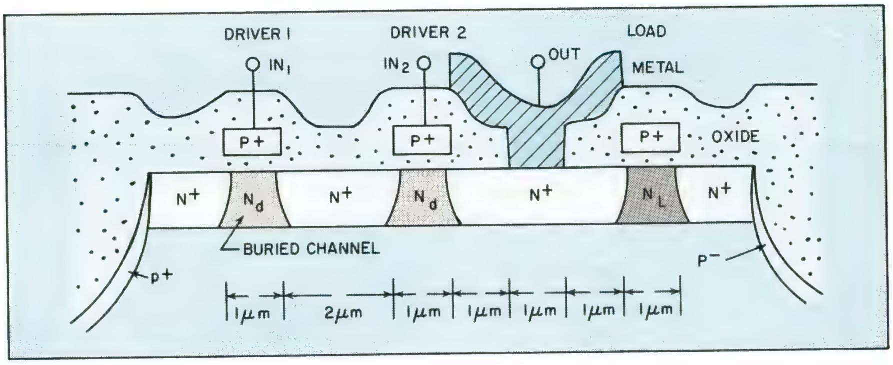
CIRCLE NUMBER 16

Japanese designs bring together high-performance technologies

Dave Bursky
Semiconductors Editor

New structures from Japan permit technological combinations that push performance limits way forward. MOS devices that attain operating frequencies of 1 GHz and higher without submicrometer lithography are some of the results of innovative designs unveiled by Japanese companies at the recent ISSCC:

- Hitachi (Tokyo) has developed a new structure combining a buried JFET load with a MOSFET to produce a merged form of buried-load logic (BL²) that offers a better packing density than CMOS and CMOS-compatibility, to boot.
- Fujitsu (Tokyo), with 1-μm patterning, has developed a buried-channel MOS transistor that permits such circuits as frequency dividers to offer toggle frequencies of 1.64 GHz—the highest ever for MOS circuit structures, according to the company.
- Mitsubishi (Itami) has developed what it calls static-induction-transistor logic (SITL) and put it on the same chip with subnanosecond ECL—a combination that permits circuits such as frequency synthesizers to have 1-GHz input.



Fine-line (1-μm) patterning and a buried-channel MOS transistor yield Fujitsu circuits that can operate at frequencies of up to 1.64 GHz.

- Hitachi and NEC-Toshiba have put MOS and bipolar advances to practical use in powerful LSI processors for general-purpose applications.

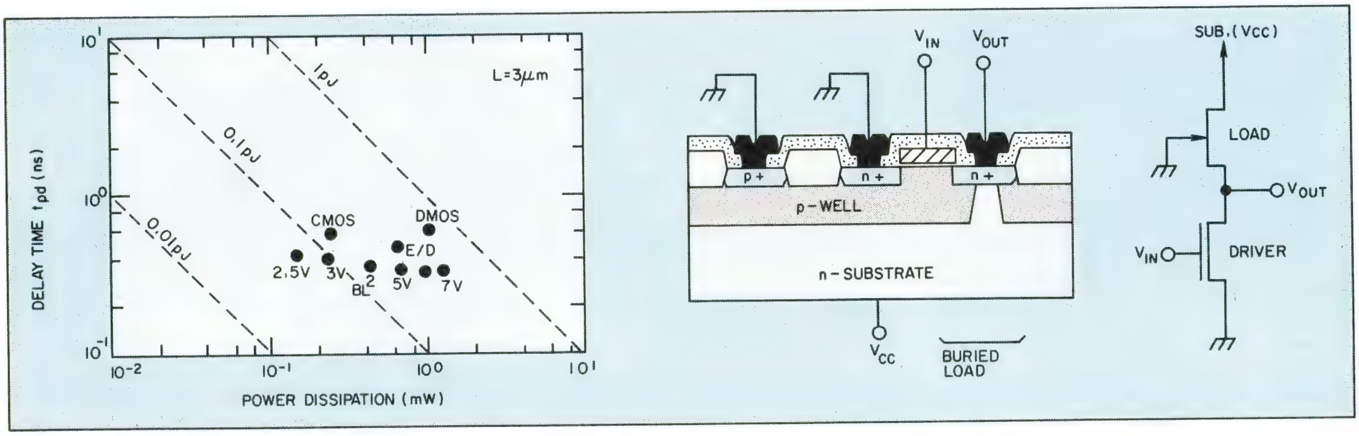
Hitachi's merged BL² technique permits the fabrication of circuits able to take advantage of the speed of BL² and the low power of CMOS. Experimental circuits include an 88-stage inverter chain, a binary counter and a full adder.

Fabricated with 3-μm MOS gates, the inverter chain has a minimum gate delay of 0.34 ns and a power-delay product of 0.17 pJ. The counter ends up much smaller than an equivalent TTL circuit—less than 55 mil². Yet its toggle frequency is 72.5 MHz with a power consumption of 4.1 mW. That means performance comparable to high-speed Schottky TTL for 1/30 the power.

Smaller, too

Moreover, the full adder occupies just 1040 μm²—about half the area of the very dense VMOS technology developed at American Microsystems.

The Fujitsu approach yields a MOS transistor that has what the company calls a built-in channel and shows a



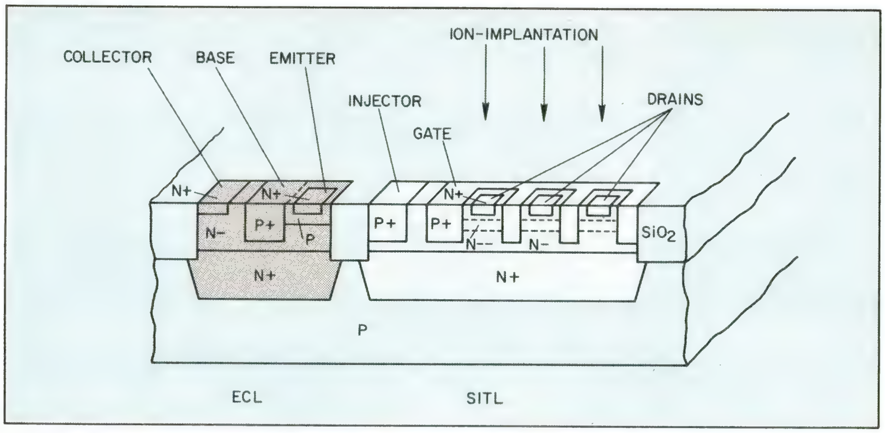
Combine a buried JFET load with MOSFETs, and the result is buried-load logic from Hitachi. Circuits using this logic form perform at almost Schottky-TTL speeds yet have the low power dissipation of CMOS.

higher carrier mobility than conventional surface-channel MOSFETs. The result? Much higher speed. Putting this device into an experimental frequency divider and a 15-stage ring oscillator fabricated with every advanced processing trick in the book—electron-beam generated masks, reactive sputter etching, and ion implantation of arsenic and boron—produces 80 to 90-ps gate delay for the ring oscillator over a wide supply range. It also produces a toggle frequency of 1.64 GHz for the counter. And the counter does it with an 8-V supply and just 87 mW of power.

Over in the bipolar area, Mitsubishi Electric uses oxide isolation to pair its own SITL with ultrafast ECL. Experimental and practical circuits fabricated with this combination include not only a 1-GHz prescaled synthesizer but also an 11-stage ring oscillator whose power-delay product is 0.07 pJ with a 1-μW/gate dissipation and whose delay time is 5.2 ns at a 100-μW/gate power level—all with a fanout of three.

The 1-GHz synthesizer packs a $^1/_{64}$ ECL prescaler and a 1000-SITL-gate phase-locked-loop system on one chip. The PLL subsystem also contains an 11-bit programmable counter, a phase detector, an 11 x 120-bit ROM, and selectors and latches for control inputs to permit 120-channel capability. For all that, the chip takes up less than 17,400 mil^2, operates from a 5-V supply and draws just 470 mW.

Meanwhile, Hitachi and NEC-Toshiba have put CMOS and bipolar to practical use in some super general-purpose chips. Hitachi's device packs 10,000 CMOS gates onto a chip that measures 490 × 421 mils (about 173,000 mil^2).



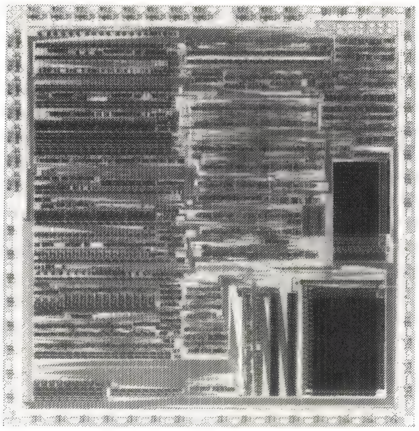
A transistor structure that uses oxide isolation to combine sub-nanosecond ECL with "static induction transistor logic" allows Mitsubishi to build complex devices having operating frequencies in the 1-GHz region.

The German connection

In keeping with the international flavor of the ISSCC, a West German company has unveiled its own technological combination. Technische Hochschule in Aichen combines ECL with injunction logic to develop "emitter-coupled injection logic" (ECIL). This high-speed logic form puts together small Schottky transistors and built-in current sources to produce small, self-isolating ECIL gates that operate in a nonsaturated mode.

In the ECIL devices, dubbed pnm transistors, the base-collector junction of a pnp transistor is replaced by a Schottky contact. The transistors are built on a p-type buried layer to provide compatibility with standard buried-collector devices. One other advantage of the pnm devices is that they don't compromise the performance of analog npn transistors fabricated on the same chip—in most I^{2}L circuits both analog and digital performance specs must be traded off to arrive at the optimum combination for a circuit.

Although ECIL cells are slightly larger than I^{2}L cells, the flexible semiconductor structure, along with multiple inputs, complementary outputs and wired-OR collector functions, permits circuits to be fabricated with high functional densities. For example, an experimental ring oscillator based on ECIL technology provides a gate delay of 4.2 ns, a 200-μW/gate power dissipation and a speed-power product of just 0.84 pJ.



A 173,000-mil^2 CMOS silicon-gate microprocessor developed by Hitachi requires just 130 mW to operate at a 400-ns machine-cycle rate. Offering an 18-line data bus and a 24-line address bus, the CPU comes housed in a 64-pin package.

Short delay times

Silicon-gate CMOS technology combined with double-layer metal enables the circuits on the chip to have a 4 to 10-ns/gate delay time. When operating with a 400-ns microinstruction cycle, the processor dissipates just 130 mW.

Processor capabilities include a large addressable memory space, highly efficient multitasking, special-purpose circuits for business data processing, and high-level RAS functions for dynamic memory control. The data bus is set up for 18 bits (16 data and two parity), and the device addressing range is 16 Mbytes through the use of a 24-bit address-save register.

Additional architectural features include eight 16-bit working registers and an ALU that can operate on decimal data in either packed or unpacked formats. Parity-check circuits and scan in/out capability are included, and users will be able to read or write directly into internal processor registers when the circuit is in its diagnostic mode. In addition, the processor has 117 basic commands in its instruction set and four operating levels, and comes in a 64-pin package.

Using bipolar technology, NEC-Toshiba has developed an 18-bit register and arithmetic unit that operates with a 400-ps microinstruction cycle. The RALU not only contains 1300 gates but also can perform a read-modify-write cycle in a mere 7 ns. What's more, multiple RALUs may be cascaded—four units can make a 72-bit ALU that operates at 100 MHz. ■■

Ceramic capacitors replace high-cost tantalums at high frequencies

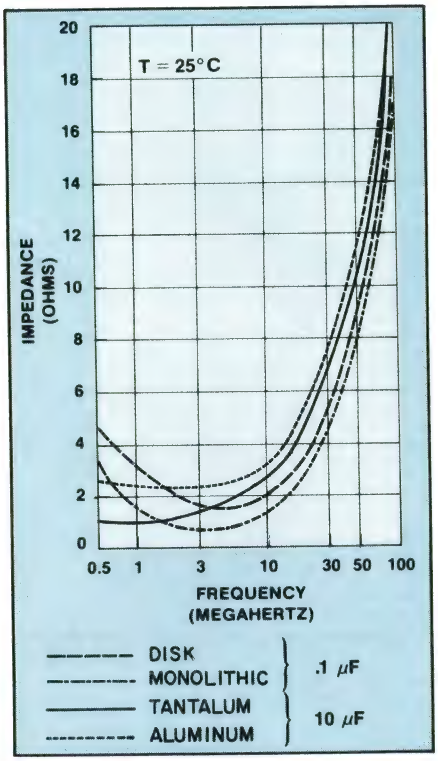
Ceramic capacitors, because of inherently lower impedance than other dielectric materials at high frequencies, can satisfactorily substitute for tantalums, silver micas and other increasingly expensive capacitors on microprocessor boards and fast logic circuits. As a result, according to test data from Centralab (Milwaukee, WI), ceramic capacitors will make satisfactory, lower-cost replacements in many bypass, coupling and filter applications involving small signals and high frequencies.

What's more, with reduced impedance come capacitance values up to 100 times less. Substituting ceramics for tantalums does not require a direct matching of capacitance values. As the impedance curve shows, a 0.1-μF monolithic ceramic provides approximately the same impedance curve at high frequencies as a 10-μF tantalum or aluminum electrolytic.

Furthermore, Centralab's test data show that ceramic capacitors have greater temperature stability and smaller dissipation factors at high frequencies. At 85 C, for example, a 1-μF ceramic, a 1-μF aluminum and a 1-μF electrolytic are fairly close in operating impedance. At −30 C, however, the tantalum capacitor shows an impedance of close to 3 Ω at 3 MHz and the aluminum electrolytic shows an impedance of 15 to 16 Ω. But the ceramic's impedance is less than 1 Ω. The dissipation factor of the ceramic, moreover, is several orders of magnitude lower than either the tantalum or aluminum electrolytics, in the frequency range from 1 kHz to 100 MHz.

Test results are derived from measurements of high-frequency impedance with a Hewlett-Packard 4815A vector impedance meter. Capacitors under test were connected with a specially designed low-inductance spring clip, with contacts made close to the capacitor's body to minimize lead in-

Stephan Ohr
Components Editor

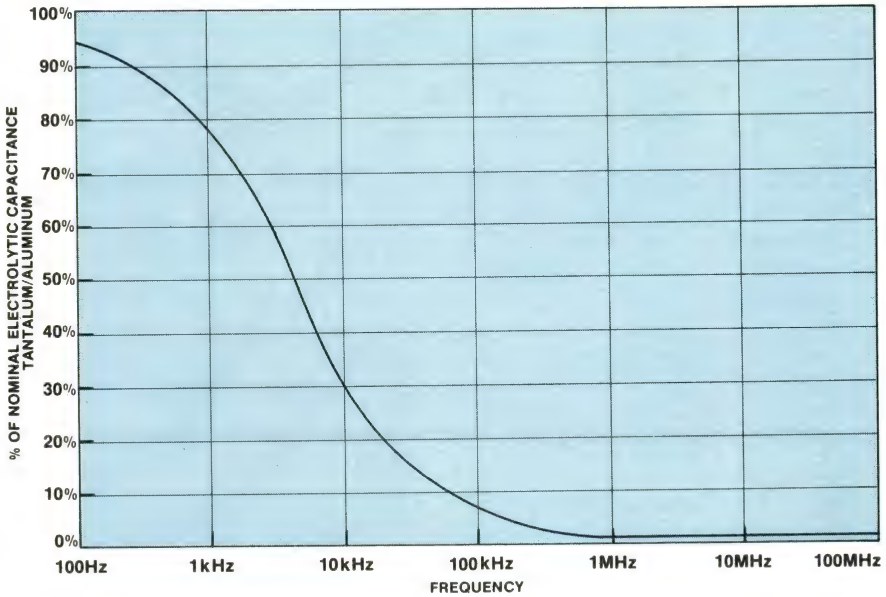


A small monolithic ceramic capacitor has about the same impedance as an electrolytic 100 times larger in capacitance.

Impedance vs Frequency

Frequency (MHz)	Disk X̄	Disk σ	Monolithic X̄	Monolithic σ	Tantalum X̄	Tantalum σ	Aluminum X̄	Aluminum σ
1-μF ceramics vs 1-μF electrolytics								
0.5	1.2	0.1	0.6	0	3.3	1.7	2.7	0.9
1	1.1	0.1	0.5	0	3.2	1.7	2.7	0.9
3	1.1	0.1	0.7	0.1	2.7	1.5	2.6	0.9
10	1.8	0.2	1.1	0.1	2.7	0.7	2.8	0.5
30	5.4	0.4	3.5	0.3	5.1	0.8	5.2	0.4
50	8.5	1.0	8.1	1.1	8.7	0.6	8.3	0.4
100	17.0	1.1	15.2	2.1	16.6	2.6	16.2	0.9
1-μF ceramics vs 22-μF electrolytics								
0.5	1.2	0.1	0.6	0	1.0	0.3	2.1	0.7
1	1.1	0.1	0.5	0	1.0	0.3	2.0	0.7
3	1.1	0.1	0.7	0	1.1	0.2	1.9	0.5
10	1.8	0.2	1.1	0.1	2.1	0.2	2.4	0.3
30	5.4	0.4	3.5	0.3	5.4	0.9	5.7	0.9
50	8.5	1.0	8.1	1.1	8.8	1.5	9.0	1.5
100	17.0	1.1	15.2	2.1	17.3	3.5	17.7	2.5
1-μF ceramics vs 10-μF electrolytics								
0.5	4.5	0.4	3.2	0.5	1.2	0.5	2.4	1.4
1	3.0	0.3	1.6	0.9	1.2	0.5	2.3	1.2
3	1.5	0	0.8	0.2	1.3	0.4	2.2	1.9
10	1.7	0.1	1.1	0.3	2.1	0.2	2.6	0.2
30	5.2	0.2	4.5	0.4	5.6	0.3	6.0	0.6
50	8.5	0.4	7.8	1.4	9.1	0.5	9.7	1.2
100	16.8	6.0	15.2	2.7	18.0	1.2	18.6	2.6

X̄ = Mean σ = Standard deviation



Far less capacitance—up to 100 times less—is required when ceramic types replace electrolytics, especially at frequencies above 100 kHz.

ductance. Every effort was made to minimize or otherwise account for the probe resistance (0.5 Ω), the probe inductance (8 nH), the fixture inductance (13 nH), the equivalent series resistance (ESR) and the inductance of the capacitor itself (3 to 7 nH). Measurements conducted at 0.5, 1, 3, 10, 30, 50 and 100 MHz, compared 1-μF monolithic ceramics with 1-μF and 22-μF electrolytics and 0.1-μF ceramics with 10-μF electrolytics.

Centralab's results (see Impedance vs Frequency Table) are among the first not only to establish the superiority of monolithic ceramics in high-frequency applications but also to provide the necessary guidelines for replacing tantalum and aluminum electrolytics with ceramic capacitance values. Tests currently being conducted by AVX Ceramics (Myrtle Beach, SC) are expected to confirm Centralab's findings. ■■

Electroprocessing shrinks line widths cleanly in microcircuits

Electroforming metal on glass and other smooth-surfaced materials produces greater interconnection density and line-width uniformity than currently available with etched-metal processes. The result? Ultrafine — as thin as 1.24 μm — interconnection line widths for hybrid-circuit chip carriers, addressing circuitry for nonimpact printing systems, thin-film sensors and other high-speed microelectronic applications. The process has been developed by the Metrigraphics Div. of Dynamics Research Corp. (Wilmington, MA)

With conventional interconnection processes, a hybrid-circuit substrate like alumina is totally coated with copper or gold interconnection material. A resist pattern is silk-screened onto the surface of the substrate and the exposed metal is etched away. Dissolving the resist pattern reveals the interconnection pattern.

The line widths obtained depend not only on the precision of the screened-on resist pattern, but also on the speed of the metal-etching solution. Fast etchants, while producing finer line widths, will also produce a great deal of undercutting and ragged edges on the interconnection lines.

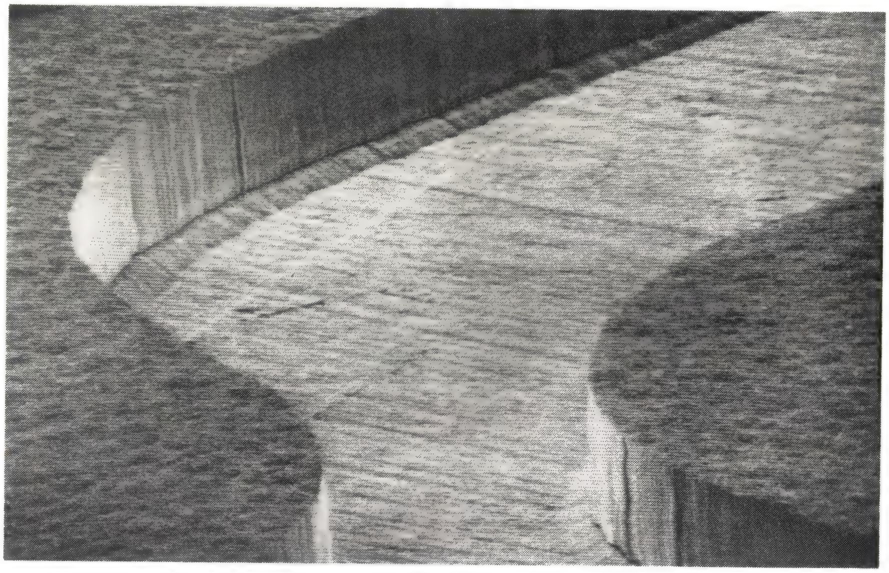
Dynamics Research, on the other hand, coats a hybrid circuit or chip-carrier substrate with a very thin layer (8000 Å) of base metal such as nickel or silver alloy. A resist pattern is then deposited on the surface of the base metal. The substrate is dipped in an electroplating bath.

Unlike the etch pattern in which the exposed metal is eaten away by a chemical etchant, the new process essentially deposits new metal layers on the surface of a base metal, in the canyons mapped out by the photoresist pattern. After electroforming, the resist is dissolved, and the thin layer of base metal is etched away in a different solution. Copper or gold interconnect lines, deposited on a base layer of nickel, will not be affected by an etching solution designed to dissolve the nickel at the base of the canyon between the interconnect lines.

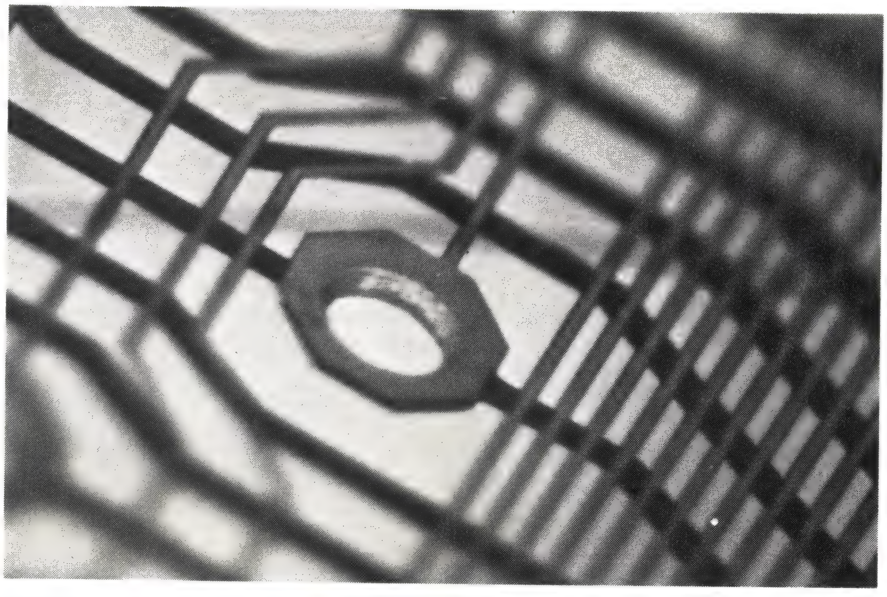
The resulting interconnection pattern is extremely fine, with clean lines. Line widths down to 5 μm can be produced routinely, and even line widths down to 1.25 μm can be obtained.

Any smooth substrate can be employed, including glass, alumina or sapphire, while interconnections and plated through-holes can consist of any electroplatable material. ■■

Stephan Ohr
Components Editor



Fine line widths without rough edges result when new layers of metal are deposited on top of a previously layed-down base metal.



Plated-through holes can be constructed on a thin glass substrate in the electroforming process.

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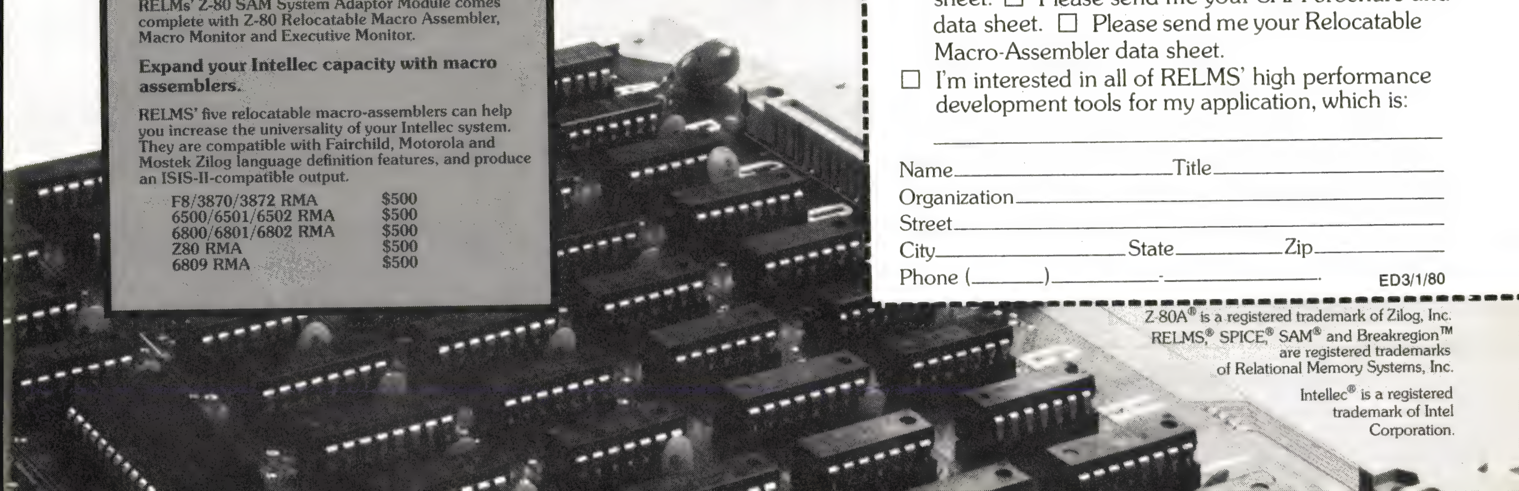

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VERSAbus conquers 16-bit μPs and challenges 32-bitters

Most microprocessor buses have their roots in the 8-bit world and begin to exhibit limitations when redesigned to handle 16 bits. The latest 16-bit μPs call for such features as multiple operating modes, asynchronous or synchronous bus operation, interrupt control, bus error/re-entry, 16-Mbyte addressing range and memory management—all difficult to obtain with 8-bit mutations.

But Motorola says its VERSAbus supports these 16-bit processors and looks beyond. It handles 8, 16 and 32-bit data transfers at 5-MHz rates from microprocessors with 8 to 32-bit architectures.

The first hardware implementation of the asynchronous bus is in Motorola's EXORmacs development system for the MC68000 microprocessor, which typifies the new generation of 16-bit μPs. As does other 16-bit μPs, the MC6800 stretches the limits of older buses in one or more of the following areas:

- Data bus width—Present buses support 8 or 16-bit widths, but cannot be expanded to handle projected data widths of 32 bits.
- Address bus width—A 16-bit address bus is available now; but 16-Mbyte address spaces demand 24 address lines, and additional lines will have to be available for the transition of 32 bits.
- Address and data parity—Neither is available in today's systems. Extra lines for parity bits will be needed to ensure data and address validity.
- Multilevel bus arbitration—Large systems of the future must handle multiple processors with varying priority levels, as more and more processors perform dedicated functions. Currently, less than a half-dozen CPUs try to control the bus, and arbitration involves merely determining which CPU requested the bus first.
- System diagnostics—The advanced microprocessors and microcomputer systems will support diagnostics for soft system errors, as well as debug and test operations. Several lines on the bus must be set aside for these functions.

The VERSAbus, however, will handle DMA transfers, accept up to seven priority interrupt levels, offer a daisy-chained bus arbitration scheme up to five levels, and provide as many as 50 peripheral I/O lines with mating ground returns. It has 32 address lines for an address range of 4-billion words. Power-supply lines on the bus include 5 and ±12-⅔ levels, as well as ±15-V levels for process control and analog applications.

Dave Bursky
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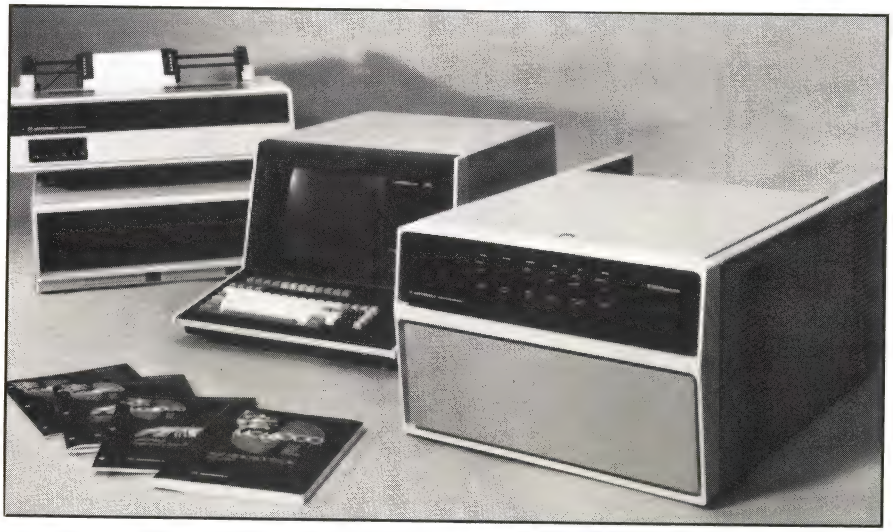

A development system for μPs, Motorola's EXORmacs uses VERSAbus for operation with processors having 8 to 32-bit architectures.

Ignoring the gauntlet

The 32-bit microprocessor may command the future, but at least three manufacturers of μP development systems are not yet ready to bow to it. A spokesman at Hewlett-Packard predicts that 32-bit designs are five years away. John Adam, manager of marketing services at GenRad/Futuredata, contends that a separate development system may not even be appropriate for 32 bitters. At Tektronix, the attitude is "wait and see;" if the 32-bit market is too narrow, Tek will not produce development systems to support it.

Reacting to the introduction of Motorola's EXORmacs development system that contains a 32-bit address and data bus (VERSAbus), the makers of "universal" development systems agreed that a 32-bit μP might eventually be expected from the semiconductor giant. However, they are in no rush to get into a 32 bit market that is three to five years away from fruition. Adam states, "We try to represent 90% of the parts that are being used in 90% of startup designs; 75% or more of our business is in 8-bit support today; and the 16-bit is just beginning."

Moreover, Adam claims, when the memory requirements for operating system and user programs exceed 20 Mbytes, a development system may not make sense. A developer might be better off working directly with an end-product design. For μPs up to 16 bits, the operating system is already about the same size as the user program. Given 32-bit architecture, contemporary designs for a μP development system would probably not make sense.

Another feature of the EXORmac system is Pascal-based language. All three representatives agreed that Pascal will be available on universal machines in 1980; all three makers include some version of Pascal instructions in their 1980 plans, but they all reject planning a development system for a μP design that does not yet exist.

Ron Shinn
Field Bureau Editor

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Designing a new circuit is always challenging, but turning an on-paper design into a functioning prototype is where the fun really begins. Signal substitution is an excellent way to speed this process and find potential design faults. For digital applications, the B&K-PRECISION Model 3300 pulse generator is the ideal signal source, because its capabilities are as wide ranging as your applications.

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For solving family compatibility problems, the 3300 can be used as an interface device to shift pulse levels of two breadboarded circuits of uncommon logic families. Distorted pulse outputs can also be reconstructed so that a clean signal can be fed to a second stage or device. A pulse-burst capability allows the 3300 to also be used as a signal source for testing counters and shift registers.

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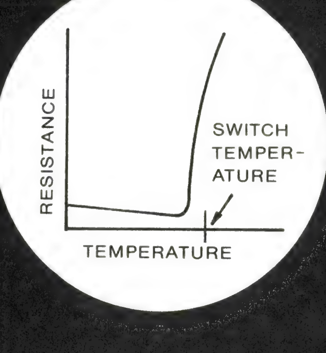
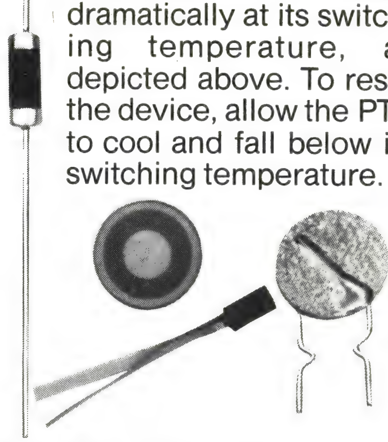


The resistance of a PTC Thermistor increases dramatically at its switching temperature, as depicted above. To reset the device, allow the PTC to cool and fall below its switching temperature.



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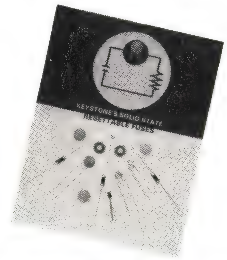

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Boards that mate to the bus are expected to be 9.25 × 14.5 in., with two edge-connector sites, P_1 and P_2. P_1 contains most of the desired lines on a 140-pin interface; P_2 contains lines that handle the I/O, expansion to a 32-bit machine, serial communications and power. In this way, the board could be cut so that just the P_1 connector remained, and it would still retain a 16-bit data path, a 24-bit address bus, seven-level priority interrupt control, five-level bus arbitration, fault detection and control lines, and power.

In addition to the EXORmacs, microcomputer board level products, slated for introduction in the latter half of 1980, will use the VERSAbus structure. It will also be applied to master-slave arrangements with an asynchronous master-slave protocol. Memories, peripherals and processors with almost any variations in speed can be intermixed without restricting the speed of the system to that of the slowest device.

Under master-slave operation, one processor or controller is designated as the current bus master, and determines data transfers to and from slave devices (including read, write and read-modify-write). In master-to-slave transfers, the master asserts a condition on the bus, the proper slave responds, the master acknowledges the slave, and the slave finally drops its response.

Motorola offers a published specification describing the bus, to encourage industry-wide use. ▪▪

Thin-film, multiturn heads push disk recording densities way up

Len Yencharis
Computers & Peripherals Editor

Thin-film recording-head technology already offers reliability and performance advantages over conventional ferrite-head technology. But multiturn thin-film heads will push the technology even further ahead—they could increase disk and tape-recording densities from the conventional 4 Mbits/in.^{2} to 10 Mbits/in.^{2} by the end of 1980 and to as much as 100 Mbits/in.^{2} by the mid-1980s.

What's more, eight-turn thin-film heads currently being designed could open the market for IBM 3370 plug-compatible and OEM disk products.

Magnex Corp. (San Jose, CA) has announced, for the fourth-quarter of 1980, a two-layer, eight-turn NiFe head that will operate on disks providing 635 tracks/in., 9000 flux changes/in. and 12,000 bits/in. Another supplier, Applied Magnetics Corp. (Goleta, CA), also plans to provide such a head this year.

In general, thin-film technology offers much more precision and control over critical high-density-transducer dimensions like spacing, gap and thickness than other manufacturing processes. With gap lengths and thicknesses in the μm range and track widths measured as close as tenths of a mil, conventional manual assembly, handing and wiring techniques become either impractical or cost-prohibitive.

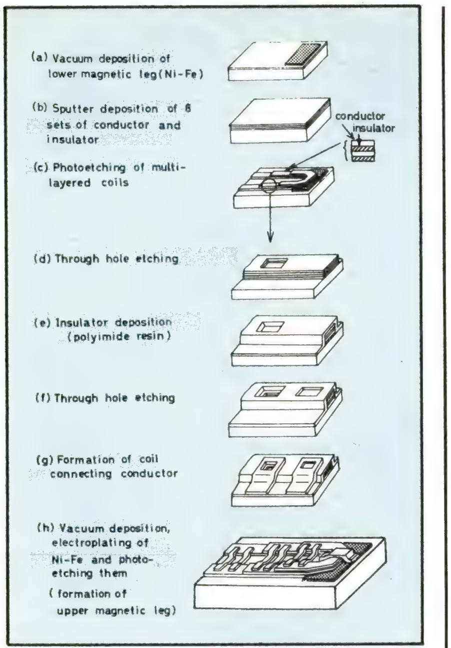
In particular, multiturn, multitrack thin-film heads offer significant performance advantages over single-turn, multitrack heads—notably, increased output signals and decreased writing current. In addition, of the two structures for multiturn heads—spiral and layered—layered types are preferable because they help reduce magnetic loss in the magnetic yoke.

Multiturn, multilayered types are fabricated in one of two ways. One way uses vacuum deposition through masks and the other uses vacuum deposition through photolithography.

The advantage to the former method is the ability to fabricate 10 to 30 turns easily. The disadvantage is that multitrack heads are not easy to fabricate this way. Photolithography offers the advantages of simple fabrication techniques for multitrack arrays. The disadvantage here is the difficulty of fabricating multilayered heads.

Multitrack, multiturn thin-film heads take eight processing steps to fabricate.

On the thermally oxidized silicon substrate, 3 μm of NiFe alloy is vacuum-deposited through a mask to form lower magnetic legs. In the second step, a multilayered conductor and insulator are deposited alternately. Then the number of conductor-insulator layers can be formed and photoetched, and the number of turns


(a) Vacuum deposition of lower magnetic leg (Ni-Fe)
(b) Sputter deposition of 8 sets of conductor and insulator
conductor
insulator
(c) Photoetching of multi-layered coils
(d) Through hole etching
(e) Insulator deposition (polyimide resin)
(f) Through hole etching
(g) Formation of coil connecting conductor
(h) Vacuum deposition, electroplating of Ni-Fe and photo-etching them
(formation of upper magnetic leg)

Fabricating multiturn, thin-film heads includes an oxidized silicon substrate, vacuum deposition and electroplating—and requires just four photoetching steps.

formed. An aluminum conductor is vacuum-deposited on top of these layers. The final step is to deposit NiFe and electroplate to a thickness as small as 3 μm.

Eight-turn heads offer advantages over two turn heads. Test results at Hitachi confirm a reduction in write current—at a flying height of 0.5 μm, an eight-turn head reduces write current by a factor of three.

Another aspect of multiturn head design that could bring positive results is to manufacture the slider assembly on the same material as the thin-film head. Magnex is proposing this fabrication technique for its eight-turn thin-film product.

Meanwhile, IBM (Yorktown Heights, NY) is working on fabricating an integrated multiturn, thin-film recording head with read and write elements fabricated side by side. The design includes track widths of 50 and 100 μm, pole thicknesses of 1 and 4 μm and gap thicknesses of 1 and 2 μm.

The windings consist of an eight-turn bifilar, planar spiral of copper, which is electroplated through a photoresist mask. The permalloy layers, composed of 81:19 NiFe, are electroplated through a photoresist pattern. The insulation is fabricated from baked photoresist, which provides leveling over winging conductors that have high aspect ratios. An oxidized silicon substrate and cover piece form the air-bearing slider. ■■

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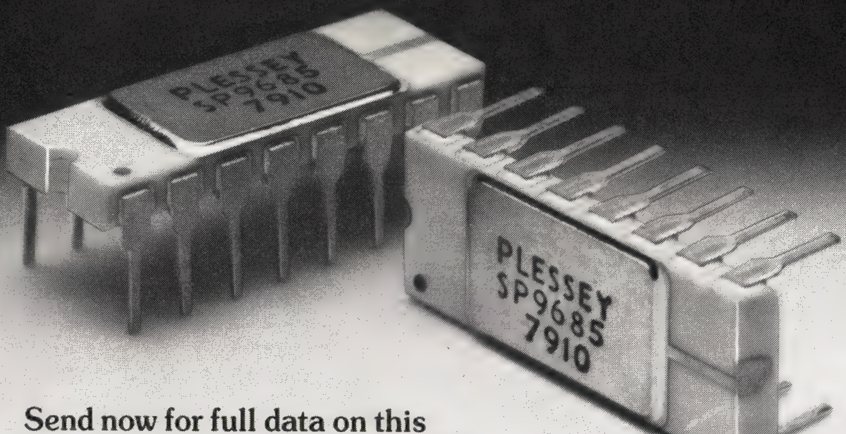

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CIRCLE NUMBER 152

P236

Electronic Design
INTERNATIONAL

Mar. 1, 1980

Portable tape recorders perform like big machines

Tiny dc-dc converters fit into standard DIPs

In-circuit emulator supports popular μPs

Conductive paste seals rf 'leaks'

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Italtel's radio mobile telephony system RTMS 101:
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with a service of the same quality
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CIRCLE NUMBER 160

Portable tape recorders give full instrumentation performance

SE Labs (EMI) Ltd., North Feltham Trading Estate, Feltham, Middlesex TW14 OTD, England. (01) 890-1477. Telex: 23995.

Modular design gives small portable machines the performance of big instrumentation tape recorders. The SE3000 series, from SE Labs, uses 1/4-in. (SE2350) or 1/2-in. (SE3500) tape transports that operate alone or coupled with a data electronics module, having a capacity up to 14 channels. The small machines provide all the features of conventional tape recorders that use 1-in. tape; they are said to be the only machines of their size and quality to offer three recording modes —fm, direct and PCM.

A basic eight-channel machine using 1/4-in. tape and offering eight speeds from 15/32 to 60 in./s, costs less than 6000 pounds sterling. At the high end of the performance scale, a 14-channel IRIG-compatible recorder, using 1/2-in. tape, is competitively priced at 9200 pounds. A version that provides four channels on 1/4-in. tape is compatible with older machines.

The eight-speed tape transports incorporate SE Labs' balanced-tension symmetrical open-loop tape path. The transport case and module housing are molded from expanded copolymer material to avoid mechanical complexity and produce a rugged light-weight package.

To get a specific recorder configuration, the user specifies the desired tape width, headstack configuration, number of data channels (record and reproduce are on a single card), recording and reproducing modes, and the accessories required to fulfill the measurement function. A user can easily switch from 1/4-in. to 1/2-in. tape or update a system. All modifications are made by adding plug-in or bolt-on hardware.

Machines in the SE3000 series can be remote controlled and operated in any attitude—upright, on end or with the transport above the electronics for rack mounting. Maintenance is straightforward because of the modular design and the use of ribbon connections.

The machines comply with IRIG standards. A direct electronics-to-electronics facility allows the system to be checked prior to recording without running tape. A hardwired built-in calibrator module, with front-panel control and display units, provides complete calibration of modulators and demodulators and a complete checkout of all data channels.

The use of CMOS logic circuitry ensures low power consumption and high noise immunity. The recorders can run on both ac and dc power sources. Built-in switching-mode power supplies will handle any input from 11 to 30 V dc, 100 to 250 V ac (48 to 420 Hz) or 140 to 350 V dc, without the need for modifying voltage taps.

The SE3000 instrumentation recorder consists of a molded urethane copolymer box and a data box assembly. The molded box holds the tape transport, controls, head interfacing and power-supply unit, while the data box assembly contains the plug-in data channel circuits and motherboards.

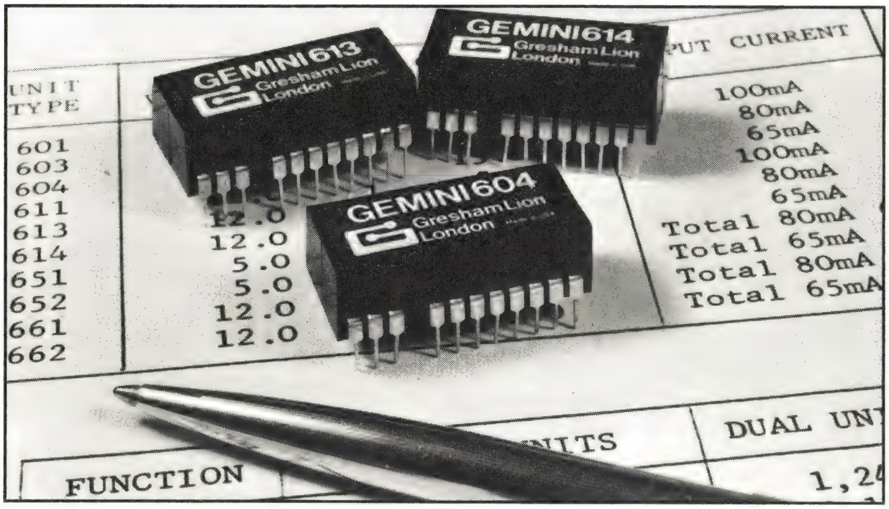
Up to 14 FM, direct, or pulse-code-modulated data channels are available, each having its own record/reproduce module with integral input/output socket. The recorder's fully modular construction permits the user to choose only those features he needs.

If required, each channel can record up to 40 hours of data in any combination of the three recording modes—an especially useful feature for operation in the field or without an attendant. The portable units weigh 55 lb and are 19 × 11 × 10 in.

CIRCLE NO. 501

Michael Elphick
International Editor

Tiny dc-to-dc converters fit DIP sockets



Gresham Lion Ltd., Gresham House, Twickenham Rd., Feltham, Middlesex TW13 6HA, England. (01) 894-5511. Telex: 27419.

A new series of 1-W dc-to-dc converters simplifies the design and assembly of on-board power-conversion systems—because they fit into standard IC sockets and printed-circuit board drilling patterns. In standard 24-pin dual-in-line packages (similar to those used for integrated circuits), the Gemini-600 series is an extension of Gresham Lion's existing Gemini Range.

The new converters can be inserted automatically and can be flow-soldered after insertion. Therefore, unlike most packaged dc-to-dc converters, they are completely compatible with the high-speed assembly techniques used in the manufacture of modern electronic equipment.

Though tiny, the new units have all the features of much larger converter modules. Available with single and dual outputs, they have output regulation and are fully isolated and short-circuit protected.

For the first units in the Gemini-600 series, the nominal input voltages are 5 or 12 V dc. Each of these input voltages provides five possible output configurations: 5 V dc, 12 V dc, 15 V dc, ±12 V dc and ±15 V dc. All outputs are adjustable by 5 %.

Load regulation is a low 150 mV for load changes from zero to full load. Output ripple has a guaranteed maximum value of 30 mV pk-pk. Internal and external circuits are protected by current limiting — which ensures that the short-circuit current is only 150% of full-load current.

The dual-in-line plastic packages have overall dimensions of 1.28 × 0.6 × 0.55 in.

CIRCLE NO. 502

In-circuit emulator supports popular μPs

Microsystem Services, 11 Duke St. High Wycombe, Buckinghamshire HP13 6EE, England. (0494) 41661. Telex: 837187.

A universal in-circuit emulator, the μSE, supports the Z80A, M6800, 8080A, 8085, M6802 and the 8048 family of microprocessors. Emulation is at the full operating speeds of the μPs (up to 6 MHz for the 8048). Developed by Millenium Systems in the U.S., the instrument can be used alone or with a dedicated microcomputer development system.

Under the in-circuit-emulation technique, an external device (in this case, the μSE), replaces the microprocessor in a system under test. The processor functions can then be monitored in a real-time environment. When the μSE is used for emulation, the microprocessor is removed and replaced with a 40-pin connector that is linked via a pod to the μSE. A microprocessor in the pod replaces the system's CPU.

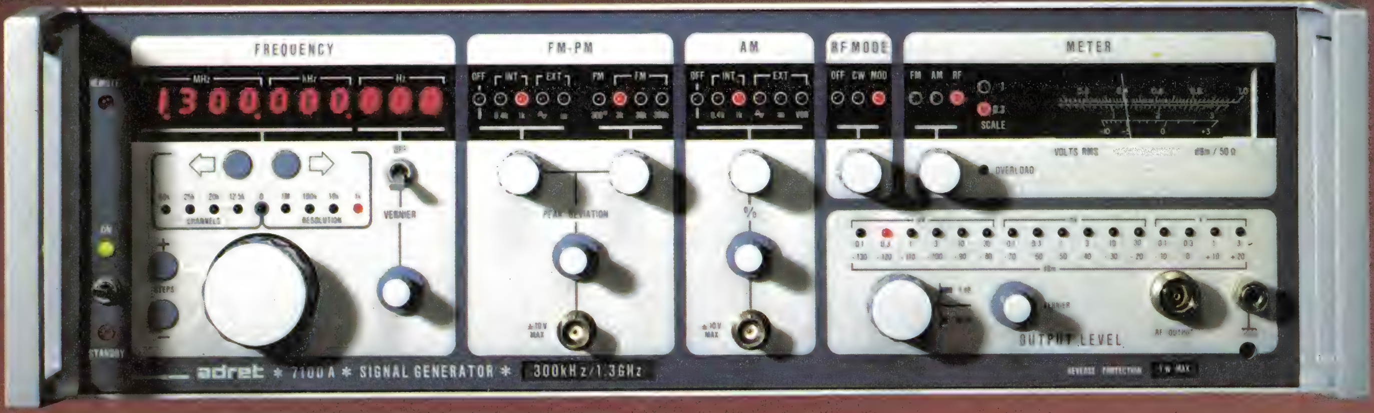
As a stand-alone emulator, the μSE handles single-step operation; sets hardware breakpoints; examines registers, memory and I/O values; and performs diagnostic checking. Thus, the user has a versatile instrument for isolating system and subsystem faults during product development. The μSE can also execute diagnostic and test programs to conduct functional go/no-go assurance tests. An optional real-time trace module further increases its debugging capabilities.

The μSE can connect via an RS232 link (operating at 110 to 9600 Bd) to any other computer system, converting that system into a microprocessor design station. Furthermore, it can connect via the same link to a dedicated development system. It converts the system into a universal development system capable of handling any processor that the μSE supports.

The optional real-time trace module provides a comprehensive record of 128 past operations. The trace can be set to trigger before or after an event by some predetermined period.

CIRCLE NO. 503

THE NEW GENERATOR ADRET 1300 MHz SERIES 7100 B



AUTOMATIC OR MANUAL SAME CAPABILITIES

No matter the user you are, of generator or synthesizer, the 7100 B, meeting point of both of these techniques, suits you.

Built in an automatic system, or in a manual set-up, its microprocessor eases its operation without sacrifying any of its outstanding performances.

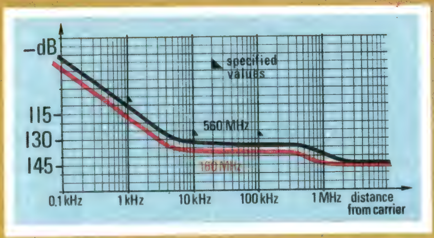
ONE RANGE ONLY, 0.1 THROUGH 650 OR 0.1/1300 MHz

You cover the entire frequency range without any sub-range switching, the frequency setting being either achieved in a pseudo-continuous mode-by a coding spin wheel, or by discrete standard frequency steps of 12,5 - 20 - 25 - 50 and 100 kHz.

The delivered frequency is in direct relation with the stability and accuracy of the built-in quartz crystal time base (5.10^{-9}/24 h) and the maximal resolution as high as 1 Hz with a vernier.

NOISE FLOOR 145 dB/Hz at 600 MHz.

Equally as performing as the best cavity generators (130 dB/Hz at 10 kHz), the 7100 B also provides a spectral purity at 1 kHz from the carrier (115 dB/Hz) to the carrier, close to that of an iterative synthesizer.



Harmonics at – 30 dB and spurious at – 100 dB added to its outstanding spectral purity makes it the ideal instrument for the most difficult tests on VHF and UHF receivers.

A 160 dB DYNAMIC OUTPUT

You adjust the output level from + 20 dBm to – 140 dBm/50 Ω by one single control, providing simultaneously two resolutions 1 dB and 10 dB by a mere push, while directly reading the 1 dB steps on an autoranging galvanometer.

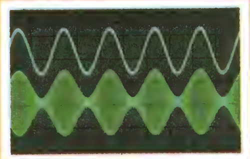
The output level accuracy specified at ± 3 dB takes into account of all errors, attenuator, flatness, etc. within the range 1/650 MHz. The output stage is optionally protected either by a fast melting fuse or an automatic breaker, and the RF leakage is less than 3 µV.

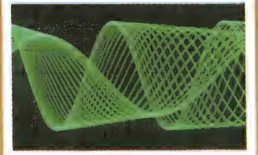
CALIBRATED AM-FM-ΦM MODULATIONS

Simultaneous AM + FM or AM+ΦM can be achieved either by internal 400 Hz or 1 kHz source or by an external signal from DC to 150 kHz (AC or DC coupling).

The AM modulation has a VOR/ILS capability for radionavigation mesurement.

The FM modulation with a deviation of up to 300 kHz makes possible FSK modulation, the pseudo-carrier being always referred to the crystal time base.





The ΦM modulation can be also performed from DC to 50 kHz.

All modulation characteristics, deviation in FM and ΦM and depth in AM are easily read on an autoranging galvanometer (2 sub-ranges).

ALL THESE FUNCTIONS ARE IEEE 488 PROGRAMMABLE

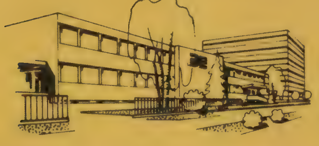
All these performances make it a true reliable and dependable generator in local mode, and much more than a synthesizer when programmed.

Adaptable on all systems using the IEEE 488 bus, its remote operation using a clear and understandable language is really easy, eventhough you are not familiar with this technique. With all these VHF/UHF performances, it turns out the chores of manual tests so far performed, into a fast and easy automatic procedure.

A COMPLETE INSTRUMENT

Eight options extend the capability of your generator 7100 B by precisely tailoring it to your exact needs :

- Output protection by fuse or automatic breaker
- Frequency doubler (1.3 GHz)
- IEEE bus programming of all functions
- Frequency extension down to 100 kHz
- 400 Hz line frequency



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12, avenue Vladimir Komarov • BP 33 78192 Trappes Cedex • France • Tél. 051.29.72 •
Télex ADREL 697821 F • Siret 679805077 - 00014 • CCP Paris 21 797 04 •

adret ae electronique

CIRCLE NUMBER 161

Conductive paste solves rf shielding problems

Emerson & Cuming (UK) Ltd., Colville Rd., Acton, London W3, England. (01) 992-6692.

A single-component conductive paste can replace soldering, welding and brazing, to seal the "leaks" in equipment that allow rf interference. Eccoshield SX from Emerson & Cuming is a conductive sealant and gasketing material made with a high concentration of pure silver particles in silicone resin. The paste has a fine texture and never hardens; thus, it remains flexible and will not flake off.

According to the manufacturer, structures sealed with Eccoshield SX have demonstrated measured insertion losses of more than 100 dB for both electric and magnetic fields from 10 kHz to 10 GHz.

The paste applies to seams or threads with a knife or spatula. If the paste is too thick, toluene can be added sparingly to reduce the consistency. With reduced viscosity, the paste can be applied more quickly with a syringe.

The product has been tested in contact with aluminum, copper, steel, galvanized sheet, stainless steel, brass and bronze—in every case, it was found to be compatible. Joints sealed with Eccoshield SX can be opened periodically without the loss of shielding performance—provided a sufficient quantity of the paste remains to fill the gap.

Both the electrical and thermal conductivities are excellent. Volume resistivity of the paste is less than 0.005 cm. The thermal conductivity is approximately 50 Btu-in. per h-ft^2-°F—or 0.017 cal-cm per S-cm^2-°C. Therefore, Eccoshield SX can be used as a heat-transfer path for electronic assemblies.

The paste has been used on sheet-metal cabinets for electronic equipment. The walls of the cabinets were spot welded or bolted together, and the paste was applied to the seams to produce a continuous rf seal. In other applications, the material has been found to outperform knitted metal gaskets for the cover plates and entry ports of conduit junction boxes. In addition to providing shielding, the material formed a moisture seal and prevented corrosion.

CIRCLE NO. 504

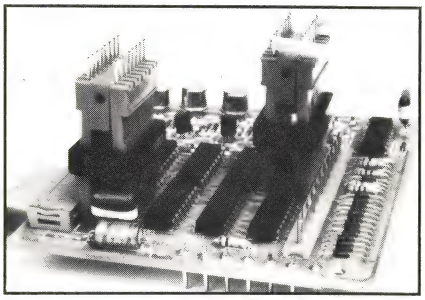
Hard-copy unit works with most video displays

Tektronix International Inc., European Marketing Centre, P.O. Box 827, 1180 AV Amstelveen, The Netherlands. (020) 471146. Telex: 18312.

Most video display units that have "Video-Output" terminals can now be connected directly to the Tektronix 4632, to obtain high-quality paper copies of screen displays at the touch of a button. A new option for the 4632 now offers improved copying of non-interlaced signals from sources such as the DEC MINC VT105 terminal. Each raster line of graphic or alphanumeric information is expanded to give smooth, high-resolution copies in seconds. Also, the hard-copy unit can provide copies of gray-scale information. Up to five discernible levels are standard, and up to 11 can be provided as an option. This capability makes the unit ideal for medical applications. A multiplexer is also available, so that the copier can be shared between as many as four video sources.

CIRCLE NO. 505

Test clips check ICs mounted on PC boards

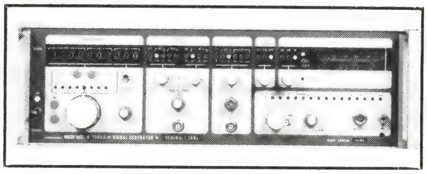


Facom S.A., 6 et 8 Rue Gustave Eiffel, B.P. 33, 91420 Morangis, France. 909-3423

A series of three test-clip assemblies, Models 1808-16, 1808-28 and 1808-40, clamps onto dual-in-line ICs while they're mounted "in situ" on PC boards. The test clamps are intended for ICs with 14/16 pins, 26/28 pins and 30/40 pins, respectively. To ensure positive contact, the pins on the test clamps are carefully polished and are made of phosphor-bronze, which is nickel plated and then gold plated. Their elasticity provides substantial contact pressure. The test clamps are compact to allow use with PC boards that have high component density. The contacts have fine tips, and a sliding sleeve locks to prevent accidental separation.

CIRCLE NO. 506

Signal generator offers high spectral purity



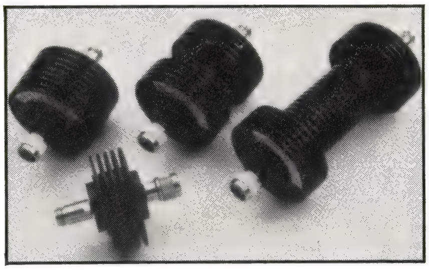
Adret Electronique France, 12 Avenue Vladimir Komarov, BP33, 78192 Trappes Cedex, France. 051.29.72. Telex: 697821F.

The 7100B signal generator offers all the features of Adret's earlier 7100A, but now includes a fan for improved cooling. Like the 7100A, the

AM/FM/PM generator combines the spectral purity of cavity-tuned generators with the qualities of a high performance synthesizer. It is controlled by a microprocessor for ease of operation in manual setting, as well as in remote programming. As an example of the spectral purity, the generator achieves phase noise of −131 dB/Hz at 12.5 kHz deviation, and a noise floor of −145 dB/Hz, for a carrier frequency of 560 MHz. The instrument has a frequency range of 300 kHz to 650 MHz with 1-Hz resolution. Options give an extended range of 100 kHz to 1.3 GHz. A self-test system allows the main internal signals to be monitored without opening the instrument.

CIRCLE NO. 507

Coax power attenuators handle 50 W at 18 GHz



Radialle S.A., Micronde Dept., 101 Rue Philibert Hoffman, Zone Industrielle Ouest, 93116, Rosny-Sous-Bois, France 854-8040. Telex: 220673F.

High-performance versions have been added to Radialle's range of coaxial attenuators. The new attenuators can dissipate 50 W at 18 GHz, and are available with attenuations of 3, 6, 10 or 20 dB. Equipped with Type-N precision connectors, they cover a frequency range of 2 to 18 GHz. Their VSWR is better than 1.6 from 2 to 5 GHz, and less than or equal to 1.35 from 5 to 18 GHz. Attenuation accuracy is ±0.3 dB for the 3 and 6-dB models, ±0.4 dB for the 10-dB model and ±0.8 dB for the 20-dB model.

CIRCLE NO. 508

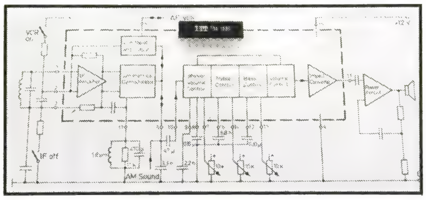
Function generator gives high output voltages

N.V. Philips Gloeilampenfabrieken, Science and Industry Div., P.O. Box 523, 5600 AM Eindhoven, The Netherlands. (040) 784616. Telex: 51573.

A function generator, PM5131, delivers a maximum output of 30 V pk-pk and has facilities for both internal and external sweep. It provides sine, triangular and square waves in logarithmic ranges from 0.1 Hz to 2 MHz. A frequency offset vernier allows an adjustment of ±20%. Up to 20 dB of continuously variable output attenuation is provided, in addition to fixed attenuation, in 10-dB steps up to 60 dB. The main output has a 50-Ω impedance, and there is a separate TTL output. Sweep range and period are adjustable. With internal sweep, the period can be 10 to 150 s. Housed in a sturdy metal case, the instrument measures 140 × 310 × 330 mm. Power consumption is 21 W. The instrument runs on 115 or 230 V ac, ±15%.

CIRCLE NO. 509

IC provides circuits for TV AM sound channel



Intermetall GmbH, P.O. Box 840, D-7800 Freiburg, Federal Republic of Germany. (761) 5171. Telex: 7-72715.

A bipolar IC, TDA1235, provides an AM sound channel for a television receiver. It includes a symmetrical i-f amplifier (with good limiting characteristics), a symmetrical coincidence demodulator, a volume-control circuit (with Fletcher-Munson characteristics), bass and treble control and an impedance converter for direct drive of a power amplifier. The volume, bass and treble controls are dc driven so that they can be operated by linear potentiometers for simplicity. Access for a video recorder is provided by the IC.

CIRCLE NO. 510

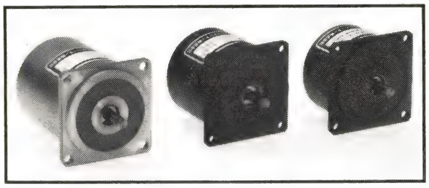
EPROM programmer is controlled by μP

Intersil Electronics Ltd., Snamprogetti House, Basing View, Basingstoke, Hampshire RG21 2YS, England. (0256) 57361. Telex: 858041.

A microprocessor-controlled programmer, Model 6920, is intended for use with IM87C48/C41 single-chip microcomputers and IM6653 and IM6654 CMOS EPROMs. An expansion capability for up to three additional types of EPROMs is provided in the hardware. The programmer can be operated with a terminal, as a stand-alone unit or as a peripheral to a computer. Interfaces for RS232C and 20-mA current loop are built in. Any of 14 different baud rates, from 50 to 9600, can be selected by a switch on the rear panel. The microprocessor firmware contains 16 different editing, loading, listing and programming commands. Data can be loaded or dumped in ASCII, hexadecimal or BNPF formats, displayed in any of 15 number bases, or used for EPROM programming in either complementary or normal modes. Check-sum generation ensures data accuracy; EPROMs are checked for erasure and verified during each programming execution. The unit operates from line power of 120 V, 60 Hz or 240 V, 50 Hz—operating voltage is field selectable and separate fuses are provided for each voltage. In single quantities the 6920 system costs £ 695. Optional cables (6921 for RS232C and 6922 for current loop) are £ 36 each.

CIRCLE NO. 511

Stepper motors are fast yet powerful



Nippon Pulse Motor Co., Ltd., No. 13-16, 2-Chome, Hongo, Bunkyo-ku, Tokyo 113, Japan. (03) 813-8841. Telex: J23539.

Stepper motors in the PA series provide large output and superior response, even at high pulse rates. Models PA-62, PA-49 and PA-35 provide stable operation over a range of starting rates and with wide variations in pulse rate. All three are 4-phase units with 15° step angles, and have maximum starting pulse rates of 1000 pulses/s. The largest of the three units, PA-62, weighs 500 g and has a peak holding torque of 1500 g-cm. The smallest unit, PA-35, weighs 230 g and has a peak holding torque of 400 g-cm. Suitable drive units for these motors are available from the manufacturer.

CIRCLE NO. 512

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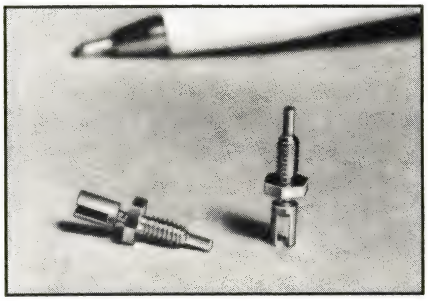
International New Products

Miniature grounding lug screws into panel

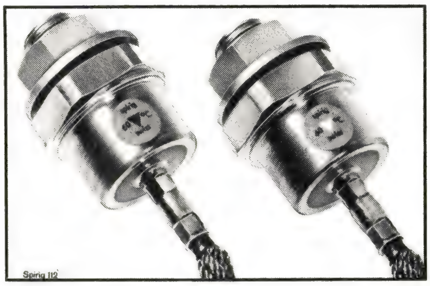


Sealectro Ltd., Walton Rd., Farlington, Portsmouth, Hampshire, England. Cosham 73211. Telex: 86142.

A threaded grounding lug, type 229-3027, can be screwed into a tapped hole or used with a nut and lockwasher. The brass lug is tin-plated and can be used with either a metal chassis or PC board. With a length of 0.531 in., the lug has a 2-56 UNC 2A thread below the hexagonal shoulder half-way along its length. Above the shoulder, a slotted section allows wrapping and soldering of multiple leads. An additional protruding lug below the threaded portion allows extra soldered connections on the other side of the panel.

CIRCLE NO. 513

One-shot indicators record device temperature

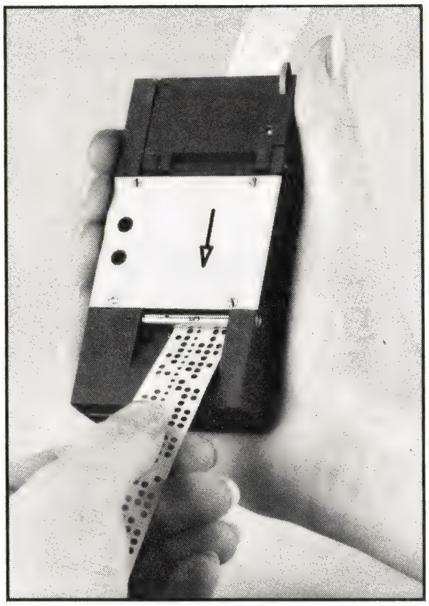


Spirig Industries, P.O. Box 160, CH-8640 Rapperswil, Switzerland. (005) 274403. Telex: 75400

CelsiDot temperature indicators give precise and positive proof that a specific device temperature has been exceeded. These small one-shot indicators can be easily applied to any piece of equipment for which the operating temperature is critical. Overheating can then be monitored and permanently recorded. The tiny stick-on buttons measure only 10 × 15 mm (0.39 × 0.598 in.), or 1-cm diameter for a circular version, and they have a pressure-sensitive adhesive backing. Because they cost only 10 cents each in large quantities, they can be freely used wherever temperatures must be monitored. The adhesive buttons have a thickness of only 0.3 mm (0.012 in.), so their sensitive white indicator triangles rapidly turn black within 0.5 s after reaching the limit temperature. Their rated accuracy is ±1%. Specific limit temperatures are available from 40 to 260 C, usually in increments of 3 to 6 C.

CIRCLE NO. 514

Small punched-tape reader avoids moving parts



AEG-Telefunken, Zentralabteilung, Theodor-Stern-Kai 1, D-6000 Frankfurt 70, Federal Republic of Germany. (0611) 600-4511. Telex: 411076.

Said to be the world's smallest punched-tape reader, a new Telefunken unit weighs just 20 g and has dimensions of only 100 × 50 × 20 mm. Reliability is enhanced by a photoelectric sensing technique, minimizing the number of moving parts. The reader has a wide range of possible uses for loading microprocessors, PROMs and ROMs. Independent of the codes employed, the reader handles both 5-bit and 8-bit tapes. The information read is available in parallel form on a character-by-character basis. Punched tape is fed into a guide shaft and pulled through the reader by hand. Speed may vary from 1 mm/s to 5 mm/s—corresponding to a maximum reading speed of 2000 char/s. For CMOS circuitry, the reader has a fan-out of 10; for TTL the fan-out is one. Operating voltage is from 4.5 to 12 V; at 5 V the current consumption is about 60 mA without indicator lamps, and 160 mA with lamps.

CIRCLE NO. 515

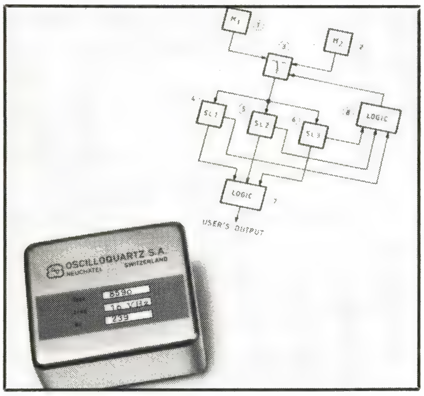
Measure field strength with versatile receiver

Rohde & Schwarz GmbH, Muhldorfstrasse 15, Postfach 801469, D-8000 Munchen 80, Federal Republic of Germany. (089) 412926.25. Telex: 523703.

The ESH-2 test receiver can be used for field-strength measurements of either wanted or interfering signals according to CISPR and MIL regulations. Other uses include tuned-frequency voltage measurements in the lab and test department, and radio-monitoring measurements from 10 kHz to 30 MHz. The receiver can be tuned quasi-continuously, in steps of 100 Hz or 10 kHz, over the entire frequency range without band switching. Its six-decade LCD frequency display is crystal controlled. The level meter has a linear range of 20 dB and two logarithmic ranges of 40 and 60 dB. Ideal for field use, the compact unit has a rechargeable battery which can be installed in place of its conventional power supply. It can be powered directly from a 12-V vehicle supply or via an accessory 24-V adaptor. Addition of loop and rod antennas to the ESH-2 forms a field-strength measuring set, called the HFH-2.

CIRCLE NO. 516

Stable crystal oscillator can be slaved to master

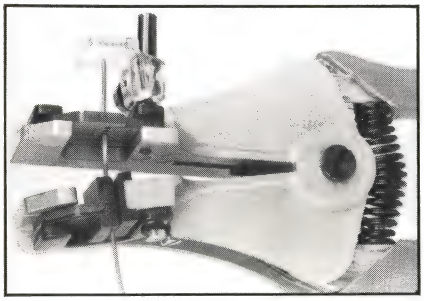


Oscilloquartz S.A., CH-2002, Neuchatel 2, Switzerland. (038) 258501. Telex: 35315.

A temperature-compensated crystal oscillator has a built-in servo loop to slave its frequency to a master frequency source. The first version operates at 8.192 MHz, but other versions are available. A dc output is provided, with its voltage proportional to the frequency difference between the reference frequency and the internally-generated signal. Intended for synchronized telecommunications networks, the unit allows users to apply the reference frequency directly to the oscillator—avoiding a separate phase comparator, integrator, filters and malfunction detector circuits. Oscillator stability is ±1 ppm from 10 to 50 C. The compact unit (70 × 60 × 30 mm) requires +5 V supplies and has a built-in regulator.

CIRCLE NO. 517

Wire strippers handle Teflon and Kapton



Facom S.A., 6 et 8 Rue Gustave Eiffel, B.P. 33, 91420 Morangis, France. 909-3423. Telex: 600757 F.

Two wire stripping tools, 165-1 and 165-2, deal with the delicate problems of stripping wires insulated with Kapton and Teflon. Together, the two tools cover all wire gauges from 10 to 26 (both European and American standards). The precise blades—machined by electro-erosion—guarantee a perfect circular cut. The jaws hold the wire tightly without marking the insulation. Stripping is achieved without damage to the surface of the core.

CIRCLE NO. 518

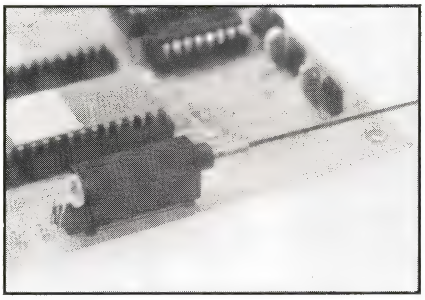
Compact panel meter measures temperature

AOIP, Departement Mesures, 83-85 Boulevard Vincent-Auriol, 75013 Paris, France. 584-1540. Telex: 204771F.

The TNL-620 digital thermometer mounts easily on a panel and occupies an area of only 48 × 96 mm. With a platinum resistor probe, it measures temperatures from −240 C to +1200 C with 0.1 C resolution, or from −200 C to +198 C with 0.01 C resolution. The instrument's accuracy is ±0.02% of reading plus 2 digits. Auto-zero and auto-polarity capability are featured. Readings are directly in °C, and probe linearization conforms to DIN43-760. The meter weighs 0.43 kg.

CIRCLE NO. 519

Low-cost opto connector mounts on PC boards



Radiall SA, Optall Dept., 101 Rue Philibert Hoffman, Zone Industrielle Ouest, 93116, Rosny-Sous-Bois, France. 854-8040. Telex: 220673.

An inexpensive connector mounts on a PC board and allows optoelectronic components to be linked to optical fibers. At one end, the thermoplastic receptacle accepts an optelectronic component in a TO-18 case. At the other end, it accepts a snap-in ferrule crimped onto an optical fiber. Assembly of the ferrule connector onto the fiber can be completed in less than a minute—without glue or polishing. Coupling efficiency depends on the specific components used. The connector accepts fibers with core diameters from 200 to 400 μm. The life of the coupling system is a minimum of 50 matings, and the connector operates over a temperature range of −20 to +85C. Connector dimensions are 27 × 11.5 × 7.2 mm. The cabling kit contains tools for stripping, cutting and crimping the fibers.

CIRCLE NO. 520

Fine thermocouple wires come in various materials

Ancom Ltd., Devonshire St., Cheltenham, Gloucestershire GL50 3LT, England. (0242) 513861.

A range of fine-gauge thermocouple wires, in a variety of materials and sizes, allows temperature measurement in constricted spaces. Both sheathed and unsheathed wires are available. Unsheathed wire can be obtained in iron, copper, constantan, chromel, alumel, platinum, platinum/30% rhodium, platinum/13% rhodium, platinum/6% rhodium and platinum/10% rhodium. The wire is made in sizes from 0.0005 to 0.032-in. diameter. Ancom is currently the only company in the U.K. to offer 0.0005-in. thermocouple wire. Matched pairs are available in ANSI types J, T, K, E, S and R. All fine-gauge thermocouple wires are supplied in 50-ft lengths on standard 3-in. reels.

CIRCLE NO. 521

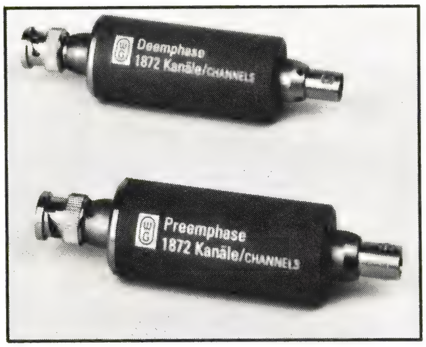
Mobile test console checks micro systems

Microsystem Services, 11 Duke St., High Wycombe, Buckinghamshire HP13 6EE, England. (0494) 41661.

A microsystem test console, MTC, is a mobile unit designed for production testing of microprocessor systems. It employs two proven techniques: in-circuit emulation and signature analysis. These allow faults to be rapidly diagnosed down to the component level. The console can be used alone or it can be controlled by a microcomputer development system or other computer system. An optional test-bed extension, with a built-in power supply, allows testing of PC boards and small systems.

CIRCLE NO. 522

Networks have the right emphasis for satcom



Wandel & Golterman GmbH & Co., Postfach 45, D-7412 Eningen u.A., Federal Republic of Germany. (071) 218911. Telex: 07 29833.

Compact pre-emphasis and de-emphasis networks have been specially designed as accessories for measurements on FM radio-link and satellite systems. They conform to pertinent CCIR recommendations for attenuation versus frequency. The networks are suitable for FM systems with voice-grade channel capacities from 12 to 1872 channels. A universal adaptor system allows the networks to be matched with all widely used rf connectors. Nominal input and output impedance is 75 Ω.

CIRCLE NO. 523

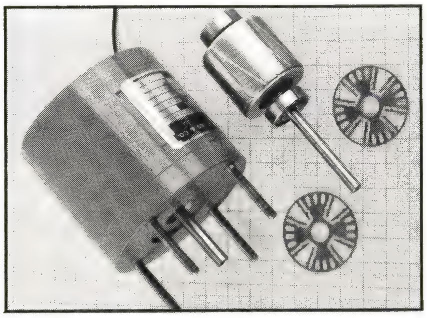
'Ugly' power supplies are available from stock

Kingslo Ltd., Abacus House, Horseshoe Rd., Pangbourne, Berkshire RG8 7JQ, England. (073) 573711. Telex: 849343.

Kingslo now offers, from stock, most of the so-called "Ugly" power supplies made by Elpac Electronics Inc. Called "Ugly" because the design emphasis is on performance rather than fancy-looking frills, these U.S.-made products carry a full two-year warranty and are technically supported by Kingslo's service center. The SOLV range of Ugly open-frame, single-output units has ratings of 15, 30 or 60 W. There are 17 voltage and current combinations varying from 5 V/3 A up to 48 V/2 A. All units are rated at 55 C and carry UL recognition. Transformers are electrostatically screened and vacuum impregnated. Other features include isolated outputs, remote sensing/programming, fold-back current limiting, remote-sense protection and reverse-voltage diode protection. Prices start at £ 19 in quantities of 50 for the SOLV 15/5. At the top of the line, the UPS-110 triple-output supply costs only £ 102.

CIRCLE NO. 524

Synchronous motors develop high torque



Walter Jones & Co., Charlton Works, Newlands Park, Sydenham, London SE26 5NG, England.

Synchronous motors, based on an advanced design, are claimed to be as robust and reliable as conventional reluctance or hysteresis types. Yet, size for size, they produce more torque and a higher starting torque. It is also claimed that there is no measurable hunting under any load conditions within the synchronous torque range. Designed and developed in conjunction with the Department of Electrical Engineering at Southhampton University, the motors are said to be particularly useful where linked drives are required to run at precisely the same speed, or where closely controlled slip has to be introduced between successive drives. Motors with starting and synchronous torques of 3 oz-in. can be supplied now. Larger sizes will be available later.

CIRCLE NO. 525

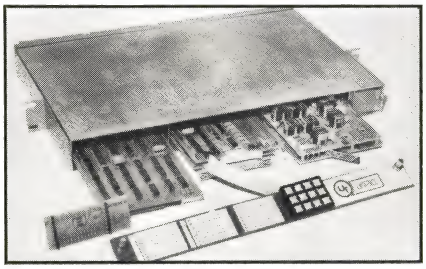
Modular digital displays offer many options

Spectra-Tek UK Ltd., Outgang Lane, Pickering, North Yorkshire Y018 7JA, England. (0751) 72941. Telex: 57725.

Spectra-Tek offers a wide range of modular digital display systems. Available with a choice of LED or gas-discharge displays, all modules are stackable. The systems interface with either TTL or CMOS logic. Available logic functions include decode, latch decode, count-latch decode and seven-wire input. LED displays are available with character sizes of 11, 16, 20 and 75 mm. For gas-discharge displays, available character sizes are 14, 25 and 50 mm. Also available are a range of accessories such as voltage converters, power supplies and a microprocessor interface.

CIRCLE NO. 526

Small modular units provide remote alarms



Uni-Tel Ltd., 1792 Birchmount Rd., Scarborough, Ontario M1P 2H7, Canada. (416) 291-3131. Telex: 06-963523.

A compact communications system, the BRC101, links up to 16 alarms and control signals to a remote site. Units for both the master and remote stations are plug-in modules for ease of installation and servicing. The compact units are designed to fill the minimum possible amount of rack space. At the master terminal, all signals are annunciated and operators can easily identify alarms as shown on insertable legends on the master front panel. The units are designed for use with telephone lines, radio, microwave and other carrier facilities. The standard power supply is 115 V ac; optional versions are available for 24 or 48 V dc. Optional filters allow simultaneous operation with voice and program material on telephone lines.

CIRCLE NO. 527

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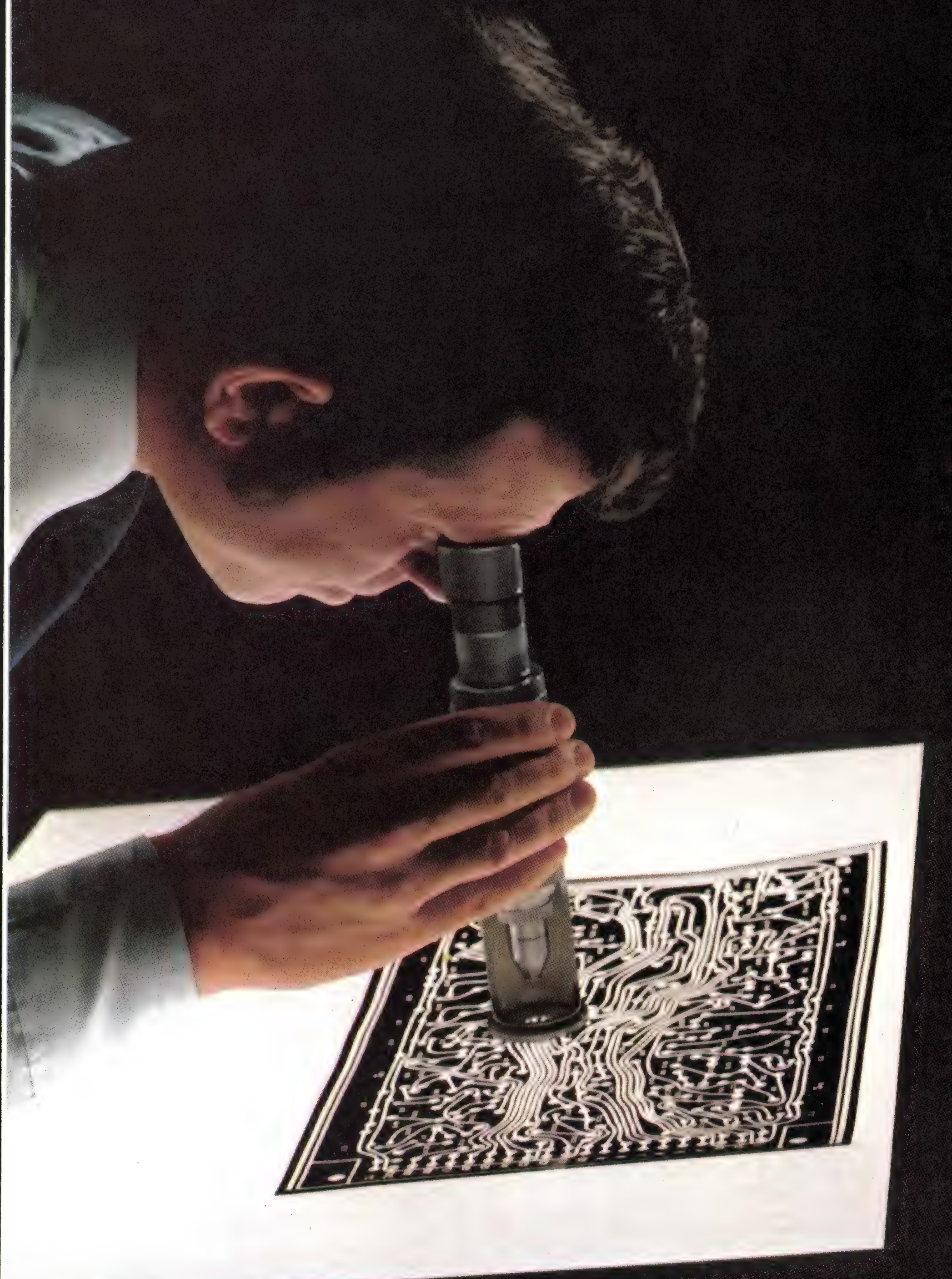

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CIRCLE NUMBER 162

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The 8520A's speed and resolution run second to none. A 500 reading per second speed at 4½-digits resolution and 240 readings per second at 5½-digits with 60-Hz line operation (200 rps at 50 Hz) let you make fast, accurate, high-speed measurements.

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Prove to yourself what this new intelligent multimeter will do for your system. Contact your Fluke Sales Engineer or Representative for a demonstration. For his name, call toll free **800-426-0361,** or use the coupon below.

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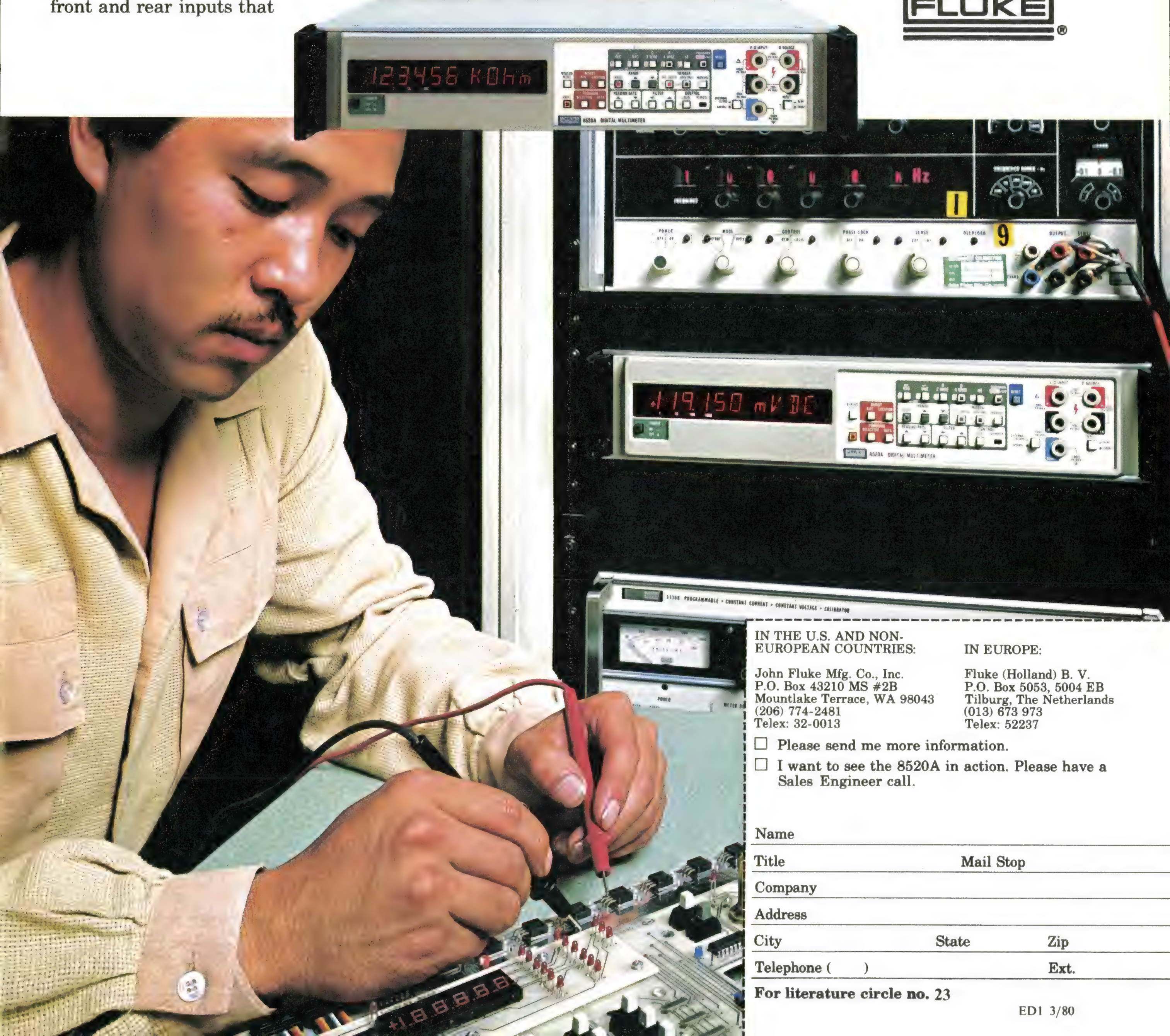

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ED1 3/80

THE 12-BIT ADC

OUR AD574 IS THE OVERALL PERFORMANCE WINNER.

The new AD574 is the lowest cost, most integrated, easiest-to-use, fullest function fast 12-bit successive approximation analog-to-digital converter you can buy.

It makes ingenious use of linear compatible I²L to pack all analog and digital functions on just two chips in a standard, hermetically-sealed 28-pin DIP. The integration of all the stages, between sensor and processor, in a single IC package means you don't have to deal with error budgets of the many individual circuit components to achieve a circuit with 0.01% linearity (over temp.) and 25 μs conversion time.

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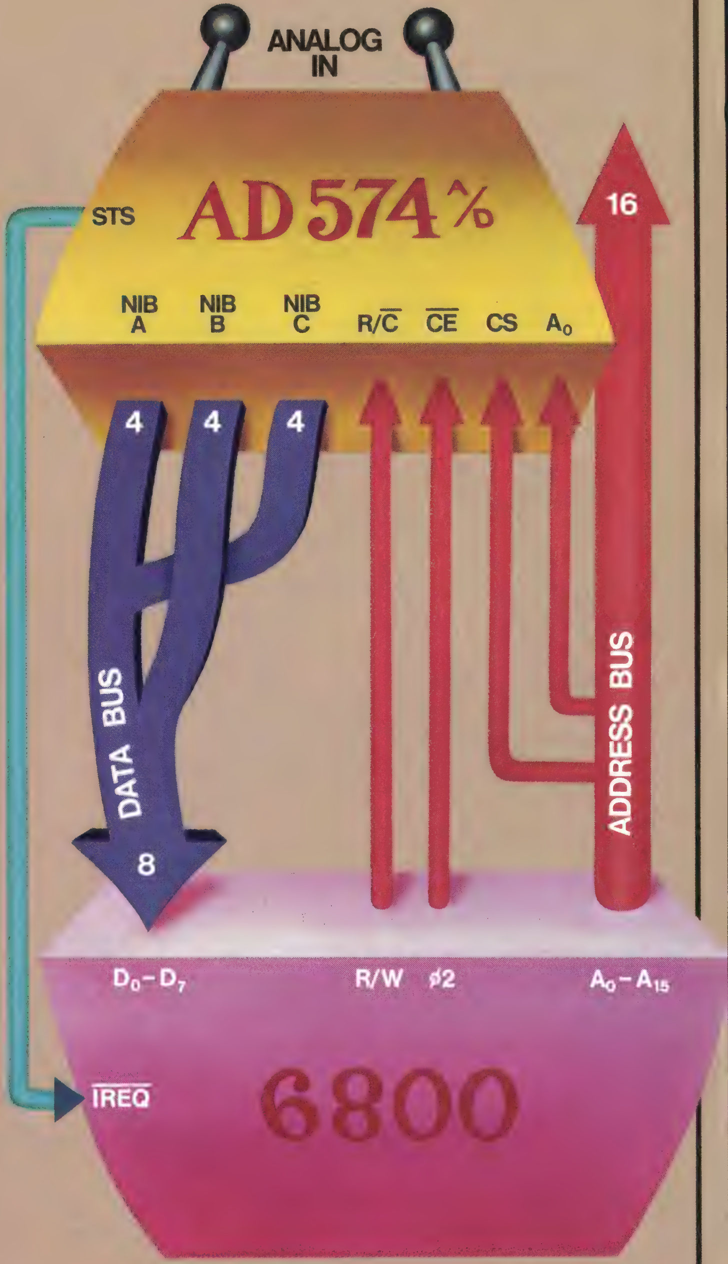
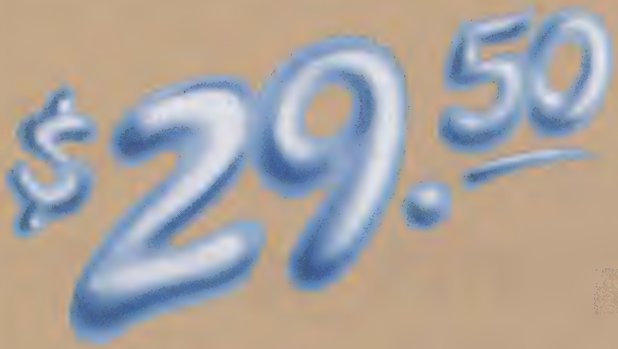


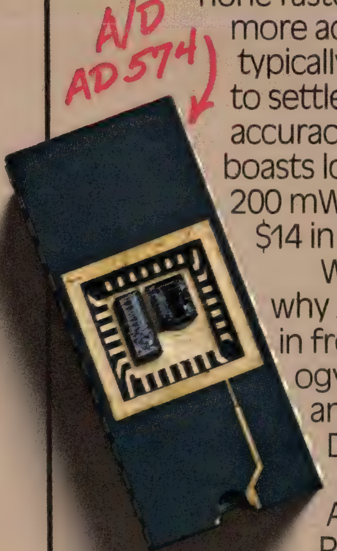
RACE IS OVER.



ANALOG TO μP. THE DIRECT CONNECTION.

The AD574 is a cinch to interface directly to most popular microprocessors with an 8-bit bus like the Motorola 6800, Intel 8080 or Mostek 3870 (F-8), or a 16-bit bus like the Intel 8086, T.I. 9900 or Motorola 68000, without any external buffers or peripheral interface controllers. Multi-mode 3-state output buffers connect directly to the data bus while the read and convert commands are taken from the control bus. Which means the AD574 doesn't tie the CPU up with conversion routines and that the AD574 can also do very well on its own as a stand-alone converter. What could be simpler? And still only cost $29.50 in 1000s. Available now from stock.

HALF THE STORY IS THE WORLD'S FIRST SINGLE-CHIP 12-BIT DAC WITH ON-CHIP REFERENCE.



The AD565 chip is the biggest single reason for the high performance of the AD574. By itself, the AD565 is the world's first monolithic 12-bit digital-to-analog converter to offer on-board low T.C. voltage reference. This makes it the best 12-bit IC DAC you can buy. There are none faster and none more accurate – it typically takes 200 ns to settle to within 0.01% accuracy. The AD565 boasts low power (just 200 mW) and low price (just $14 in 1000s).

Which proves once again why Analog Devices is way out in front in converter technology. For more information and application details, call Doug Grant or Don Travers at (617) 935-5565. Or write Analog Devices, Inc., P.O. Box 280, Norwood, MA 02062.

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CIRCLE NUMBER 50

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CIRCLE NUMBER 24

Interface 80 gives designers, users the latest words on data comm

Many of the problems facing today's data-comm system and equipment designers have roots in the ever-growing mass of hardware that can send or receive information. Terminals and processors are seemingly everywhere and, thanks to LSI and VLSI, getting more intelligent all the time. All this adds up to a demand for systems that can transfer more data faster, more reliably, but for less cost. For these reasons, Interface 80 (Miami Beach, FL, Mar. 17 through 20), comes at an opportune time—it is *the* conference for both the designer and user sides of the data-comm coin.

And the conference message is clear: Help is on the way. All digital communications systems, be they satellite-based, ocean-spanning, or fiber-optic or wire-based local loops under computer or PBX control, will provide data-oriented wide-band channels with efficient and well defined structures. These efficient transmission facilities will be supported at the equipment level by smarter interfaces carrying self-contained diagnostics and controls.

Processors and peripherals such as terminals and controllers will provide data-comm functions like modems, first as options and then, as standards solidify, as a matter of course. New net-oriented components will ensure a place for fiber optics in local loops.

At higher communications levels, the impending data-comm avalanche inspires several rational solutions, including distributing networks into manageable parts along with the processing; adopting high-level languages for specifying communications protocols; and ensuring that communications channels become transparent rather than application-specific.

All these answers underline the fact that data-comm users and designers can enjoy a productive dialogue at Interface 80. The conference helps this along by setting an informal stage. In place of submitted papers, there are talks by leading data-comm professionals. The questions and answers that follow the presentation often provide insights important enough to affect designs but not normally available to designers.

The sessions themselves are informative to designer and user alike. To make data-comm equipment more productive through multifunctionality, designers will see that hardware integration, from chip to system, plus sophisticated software (and firmware) add to and extend the capabilities of equipment formerly restricted to single users. At the terminal level, multiterminal approaches will be examined for capturing, editing and communicating data. Versatile multifunction graphics will also be discussed.

To better handle all the data the new terminals will surely generate, other sessions will focus on the continuing shift to all-digital transmission networks, nodes and equipment. Designers will learn what users expect from such all-digital facilities as voice-plus-data equipment—from handsets to PBXs. Users, in turn, will learn in designer-led sessions what improvements to expect from fiber optics in local-loop capacity, reliability and error rates—and when. Then again, designers will find out what level of transparency end users require of modules that interface to the new services. Users will also let designers know the kind of hardware and software packages they will need to get on line to the new services, along with how much programming they expect to generate and what level of support they expect to see built-in. Additional programming-oriented sessions will zero-in on simplifying data-comm software.

Distinguished data-comm professionals will guide the sessions:

- John Nuwer, Manager, Planning and Evaluation, Electronics & Telecommunications, Atlantic Richfield Corp. (Los Angeles, CA). One of the most sophisticated data-comm end users, he cautions that digital-data-comm advances could easily outpace the ability to train personnel.
- Hal Becker, Advanced Computer Techniques (Phoenix, AZ). A distributed-data-processing and data-comm-network expert who believes that in-house data-comm managers need help.
- John Gould, Vice President, DDP Consultants (New York, NY). An authoritative voice in distributed-processing technology who advocates distributing networks.
- Ralph DeMent, Manager of Corporate Network Services, Digital Equipment Corp. (Maynard, MA). A strong voice in all-digital communications who brings

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Sid Adlerstein
Communications Editor

his know-how to bear on integrating word processing and data processing on distributed networks.

- Neil Helm, Comsat Labs (Washington, DC). A clear signal right from the core of digital sat-comm technology.
- Delon Hanson, Section Manager for Fiber Optics, Optoelectronic Div., Hewlett-Packard Co. (Palo Alto, CA). A wellspring of information on new fiber-optic developments for local loops.
- Dennis Cagan, President, The David Jamison Carlisle Corp. (Los Angeles, CA). A clearinghouse of hard facts about data-processing terminals.
- Terry Easton, Chairman, Graduate Dept. of Telecommunications Management, Golden Gate University (San Francisco, CA). A noted telecomm futurist who is concerned with applying LSI technology to digitizing the human voice.

Nuwer: Get the horses

With the world—and the Bell system—moving toward digital communications, John Nuwer expects bandwidths as wide as 1.5 Mbits/s to be available at reasonable rates within two to three years. Datacomm-interface designers had better be ready, he warns. They will have to produce better results than even the new RS-449 types that can work amicably with the standard lower-speed carriers (56 and 64-kbit). What's more, the new services will also require high levels of diagnostics and controls to keep them going, he says, noting that there's little profit in going to 1.5-Mbits/s T1 transmission speed and then finding the greater portion of the system intelligence is tied up in front ending.

With the world going to digital communications, we must train professionals who are competent in both data comm and computers so that we control the new technology rather than vice versa.

John Nuwer

LSI can help, Nuwer feels, but only if it is bipolar fast. Nuwer sees a trend now toward terminals containing a line-interface card that controls the interface. Beyond these, he foresees μP-based controllers as a probable answer to such troublesome functions as communications-protocol conversion. He also wouldn't mind using intelligent interfaces to perform some of the basic front-ending operations right at the communications line itself. Armed with μP power, such controllers could provide some of the diagnostics, loopbacking and even signature analysis.

As for the protocols—especially for satellite-based services—Nuwer wants to see the delay intrinsic in sat comm addressed directly in the protocol. Pointing to polled systems in particular, he maintains that rather than switch back and forth to the bird, ground controllers should enter the loop. But while Nuwer seems confident that such overall architectures as SNA, SDLC and X.25 will provide the framework for the necessary protocols, he wonders how they will be implemented.

For that matter, who is going to do any of this development? In many data-comm areas, technology is in danger of outpacing the user's ability to cope. The professionals that will make tomorrow's world manageable should have roots in the parallel disciplines of communications and computers, Nuwer believes, adding that the time has come to start developing these engineers—or else.

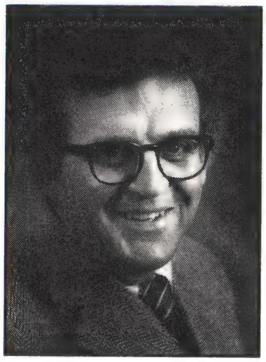
Becker: Increase comm-manager skills

Change, says Hal Becker, is the constant environment for data-processing professionals—in the user-community needs, in management practices and certainly in hardware and software technology. For example, many data-comm managers formerly responsible just for voice communications are facing a growth in terminal population so fast that their only recourse is to apply the voice-communication approaches they're familiar with to the data-comm problems being dumped in their laps.

Such in-house skills often aren't adequate to cope with such an explosion, and Becker looks to several sources to help the overburdened managers: in-house professionals, computer vendors, communications carriers and consultants. He also concedes that relying on either equipment or communications-channel vendors could backfire. Their parochial solutions often force the user into buying more equipment or

Because terminals are so numerous and smart, communications managers need all the help they can get. The people, and the comm channels they use, should not be application-specific.

Hal Becker



Sessions of special interest

The All-Digital Dimension

AD-1	Progress toward all-digital communications	Tues	9–10:30
AD-2	Integrating voice and data at the PBX	Tues	10:45–12:15
AD-3	Fiber optics: The new look in local loops	Tues	3:30–5
AD-4	All-digital satellite services: Roof-top to roof-top and beyond	Wed	3:30–5

Simplifying Data-comm Software

SS-1	New multifunction network operating systems	Mon	10:30–12
SS-2	Higher-level languages to aid data-comm programmers	Tues	10:45–12:15
SS-3	Packaged solutions improve net performance	Thur	9–10:30
SS-4	Structuring hierarchical data bases for DDP nets	Thur	9–11

Increasing Net Productivity

NP-1	Network architectures: Assessing evolving alternatives	Mon	3:30–5:30
NP-2	Designing the hybrid voice/data net	Wed	3:30–5:30
NP-3	New tools and techniques for optimizing net performance	Thur	9–10:30
NP-4	Private networks in a new package	Thur	10:45–12:15
NP-5	Update on local-network strategies	Thur	10:45–12:15

Technology Lab

TL-1	LSI and VLSI: Users to benefit from greater integration	Mon	10:30–12
TL-2	The 64-k memory chip and beyond	Tues	9–10:30
TL-3	The 8-inch Winchester and what follows	Wed	9–10:30
TL-4	Digitizing the human voice: The sound of systems to come	Wed	10:45–12:15

Processing/Communicating the Word

CW-1	Key trends for multifunction office systems	Mon	3:30–5
CW-2	Seeking teleprinters for W-P applications	Tues	3:30–5
CW-3	New ways of integrating word and data processing on distributed networks	Wed	10:45–12:15

The Corporate Message Network

CM-1	Developing a corporate message network	Mon	3:30–5:30
CM-2	The executive information service: Defining requirements	Wed	9–10:30
CM-3	Routes for delivering electronic mail . . . today	Thur	10:45–12:15

Trending towards Extended Network Services (ENS)

EN-1	Complementing private nets with ENS	Tues	10:45–12:15
EN-2	Matching ENS to current and future uses	Thur	9–11
EN-3	Viewdata's impact on future ENS offerings: Datavision vs television	Thur	10:45–12:15

International Operations

IO-1	What WARC decisions mean to U.S. users	Mon	10:30–12
IO-2	Multinational networks: Net strategies for design and management	Wed	9–11
10-3	Transborder data flow: Current techniques, issues and challenges	Wed	3:30–5

Fail-Safe Network Control

FS-1	Achieving performance goals in contemporary nets	Mon	10:30–12
FS-2	Principles of design for fail-safe network control	Tues	10:45–12:15
FS-3	Programmed maintenance: Strategy and tactics	Wed	9–10:30

Terminal Advances

TA-1	Workstations to center on CRT intelligence	Mon	10:30–12
TA-2	Teleprinters upgrade their image	Tues	9–10:30
TA-3	Transaction terminals stress versatility	Tues	3:30–5

Towards the Transparent Interface

TI-1	New architectures focus on FEPs	Tues	9–10:30
TI-2	Multifaceted modems and MUXs emerge	Tues	3:30–5
TI-3	Network nodes show more intelligence	Wed	10:45–12:15

Multifunctionality is the Mode

MM-1	Multipurpose micros proliferate	Mon	10:30–12
MM-2	DDP systems handle data entry	Tues	10:45–12:15
MM-3	New graphics tools for managers and scientists	Tues	3:30–5:30

bandwidth than he really needs.

Noting that some of today's terminals contain more processing power and memory than the computers he worked on 20 years ago, Becker sees the communications function becoming a utility to the other tools—and rightly so. As a result, application-specific logic is disappearing from communications. That's as it should be, Becker feels, so that the user community can access resources such as processing power and data bases through relatively pure pipe. Even more advanced networking is waiting in the wings, according to Becker, but he sees the lack of a workable set of standards and protocols as the main bottleneck. Things will change. As Becker sees it, higher-level vendor-independent languages like Cobol and Fortran are slowly being joined by higher-level counterparts for controlling the data-base functions. Though not vendor-independent as yet, they will be. Data bases will intersect some day.

Gould: Distribution simplifies

Technically, distributive processing and designing the data networks that tie the separated nodes together are not so demanding. But politically—well, that's another story to John Gould. The main problem is the reluctance to switch over from centralized systems to locally autonomous operations in both processing and communications. In many types of operations, particularly autonomous profit centers, distributing the processing can result in much less information being transferred. On the other hand, relatively straightforward communications tasks could grow into demons under the cover of some ponderous global protocol that attempts to manage an overly complex network.

Perhaps a greater problem than the data-comm technology for distributed processing is overcoming the reluctance to change to communications networks that are themselves distributed.
John Gould

Gould advocates simply distributing the networks and communications functions along with the processing. The key to the strategy is that no more than 20% of all the information acquired throughout the networks of most enterprises is needed centrally. Hence, remote distributed centers need send only summaries to a central site instead of entire data bases.

Gould's alternative to single, global, high-speed behemoth networks is loosely coupled sets of smaller, sleeker systems that can intercommunicate. Networking problems differ within a building, among several buildings in the same complex, across a country and worldwide.

Recognizing this, Gould simply proposes to go after flies with a swatter rather than a cannon. Because each kind of network varies in the speed, kind and volume of its data, Gould would use an appropriate streamlined communications system for each application. Pointing out that his proposal has succeeded in the infinitely complex network run by the telephone companies, Gould says he would design private networks the way public networks evolved: putting the most cost-effective solutions where they belong and then interconnect them.

DeMent: All-digital networks are planted

All-digital communications systems conveniently divide into two major types of networks for Ralph DeMent: interplant and intraplant. All-digital interplant networks will come from such sources as AT&T, when and if the giant utility makes its T-carrier systems available everywhere and extends the service down to the local PBX level. Another will be the planned SBS satellite-based system, which, DeMent emphasizes, will offer the ability to manage a user's digital bandwidth more effectively than the AT&T system.

Intraplant networks include the local plant, where, for example, there is distribution around a PBX. In this local system, DeMent sees design philosophies conflicting. Would these networks be better based on packet switching, digital switches, Ethernet-type loops? And will computer or telco-equipment manufacturers supply these nets? Even the question of transmission medium is open, DeMent says. Twisted pairs, coaxial cable, fiber optics and even open-air infrared are in contention.

As local networks develop, DeMent believes computer manufacturers will dominate data comm for the next few years; then the pendulum will swing in

All-digital communications networks have started a race for dominance of local-node design between computer and PBX makers. Whatever the outcome, we need a high-level protocol-specification language.
Ralph DeMent

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favor of PBX manufacturers. By 1990, the differences in local-net approaches propounded by computer and PBX makers should be resolved by the merging of data and telecomm.

Meanwhile, communications disciplines for handling voice and data will remain separate, DeMent predicts, adding that both segments will develop better strategies for interconnecting with one another. Whichever philosophy prevails, DeMent believes that semicomplete networks (those with unspecified termination equipment) could lead to a class of very rich consultants. The opportunity for network and equipment designers is obvious. In programming, the problem is compounded by the absence of a good language for implementing protocol specifications.

Helm: Satellites will fly high

New systems and technologies will help communications satellites handle more data faster, more efficiently and more economically—one reason why Neil Helm expects satellites to be a major data-comm carrier well into the future.

Feeling that both domestic and international versions of the communications satellites launched to date have been designed generally for telephone traffic, Helm sees the pendulum swinging toward data with the launching of the SBS satellite later this year. He considers it the first bird designed specifically to handle data traffic. For openers, it uses wider-band and more powerful transponders. In addition, its channelization techniques are unique. The new transponder designs will use the available power and bandwidth more efficiently than ever for the transmission of high data rates.

Another recent major sat-comm development that Helm feels will have an impact on equipment designers is INTELSAT's approving of time-division multiple-access (TDMA) in its No. 5 system. Implementation should follow soon because some of the transponders were designed for TDMA traffic, which should make international communications via satellite even more competitive than ever with submarine cables. In addition to its potential economy, TDMA also gives data-comm designers a well-defined format for carriers and clocks.

Helm stresses that one of the strengths that sets satellite communications apart from other transmission systems is that it is inherently point-to-multipoint. All you get from a cable, Helm notes in contrast, are its two ends.

All-digital, TDMA communications provide well-defined channelization formats and clocks, while satellites can add inherent point-to-multipoint nets instead of just a cable's two ends.

Neil Helm

Hanson: Local fiber optics is inevitable

It's only a matter of time before local loops go fiber optic. It will happen, says Delon Hanson, as soon as components become available for such functions as identifying sources, coupling and increasing dynamic range.

Fiber-optic transmission systems will become a considerable factor in local distribution as soon as the necessary cost-competitive network-oriented components become available.

Delon Hanson

At this point, however, fiber-optic components are intended for point-to-point communications links, says Hanson. For example, as they are now designed, receivers are unsuitable for connection into networks. For networking capability, receivers will need to identify signals coming from different locations on a distributed network.

Another component needed for networking fiber optics is a passive coupler, which helps with distributing the signal from a transmitter to the terminals in a cluster. Usually, transmissive-star types are used. Because even perfect passive couplers only split input-port power among the output ports, the resulting signal power reaching each receiver is attenuated by at least the tap ratio. Hence, Hanson looks toward transmitters and receivers with increased dynamic range.

The fiber-optic analog to a wire current-loop would need directional couplers, not stars. However, such couplers would impose severe requirements on all loop-system components, Hanson warns, because each coupler would introduce at least 4 dB of insertion loss. Using LED sources, he notes, it wouldn't take very many drops to deplete a loop's dynamic range. The alternative source, an injection laser diode, though it does launch more power, also introduces cost and temperature problems.

Another possibility would be to use what amounts to active coupling between point-to-point links—an alternative Hanson is leery about. Of course, failure in such devices could shut down the link, Hanson cautions. So Hanson would like to see some way to bypass failing terminals.

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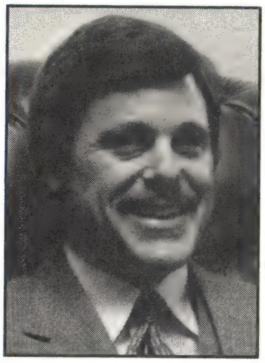
For the immediate future, Hanson sees a move toward fiber-optic link equipment with standard plug-compatible electrical interfaces such as RS-232 and RS-449, and the peculiarities of the fiber optics remaining inside the hardware.

Cagan: Terminal makers slow to change

Terminal manufacturers are in no great hurry to move away from the old standby RS-232 and current-loop interfaces—they don't feel any great pressure to do so, says Dennis Cagan. If they could be shown that implementing new standards such as RS-449 and X.21 would save them money, they would do it.

Data-communications options, such as modems, will find their way into terminals for word and message processing before going to data-processing because the computers themselves lag.

Dennis Cagan



One reason that terminal makers aren't falling over themselves to come out with the new interfaces is that the computers they must work into still use the old schemes. And Cagan doesn't see data-processing computers moving very fast in the direction of the new interfaces, either.

For a long time to come, then, terminals designed to support the new interfaces must also maintain compatibility with RS-232 to ensure that they can work into the enormous installed base.

Another reason for terminal makers' hesitation is that many terminals can outdrive the computers they work with. Traditionally, computer-driving capability has lagged behind the terminals' in both data rate and distance. Not many computer I/O's can match the 9600-baud rates and 1000-ft distances commonly provided by terminals.

Another slow-moving area is data-comm options for data-processing terminals. Here, too, cost is the main problem. The marketing challenge here is to spread many versions over the relatively few terminals that need options. Choices could range from 300 to 9600 bits/s in modems and buffers and could include protocol control and conversion as well as editing capability. For the time being, Cagan notes, some data-comm-component makers are flourishing by providing modems, buffers and other optional functions to word and message-processing equipment manufacturers.

Easton: What does the future say?

In his later years at MIT, Norbert Weiner felt that technology *per se* didn't improve the quality of life, but the quality of things. It's how we use the things that determines the quality of life. Almost reluctantly, Terry Easton is beginning to move away from Weiner's compartmentalized approach.

Perhaps, says Easton, the next step in Darwinian evolution may not be biological but IC-based. In particular, the emerging technology of LSI-based voice input/output systems makes him wonder. Microprocessor-based voice-response hardware (e.g., TI's) is already here. The next step will surely be voice entry. In its lab, NEC is operating a voice-entry device with a 200-word repertoire of continuously spoken language. For the present, the NEC system will recognize only the voice it has been trained for. But things are moving so fast that within only six months NEC expects 95% reliability in recognizing anyone's voice, in continuous conversational streams. A 200-word vocabulary, though useful, doesn't begin to rival human capability. But 2000 well-chosen words do—especially for business use. And that's imminent, according to Easton.

Hardware, especially in the form of voice-input and output adjuncts to computers and telecomm chips, will surely be part of our lives soon. How we use them will be crucial.

Terry Easton

Looking farther into the future, Easton foresees multiprocessor-based, hand-held terminals that draw on megabits of bubble memory becoming part of daily life. Add to these voice-I/O and communications capabilities via LSI transponders that can access any sort of information via broadcast intercarrier systems like Viewdata and Teletext, and today's networks look scrawny by comparison.

The changes will come, that much Easton knows. But the question in his mind remains: How much? ■■

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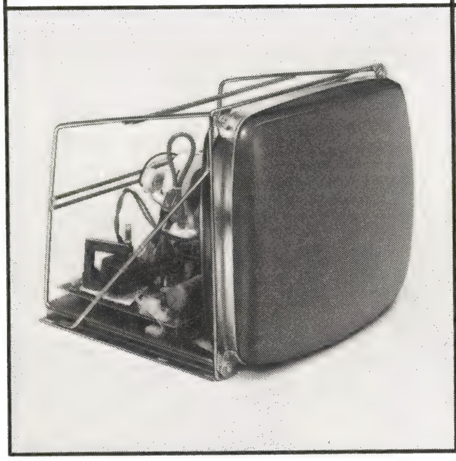	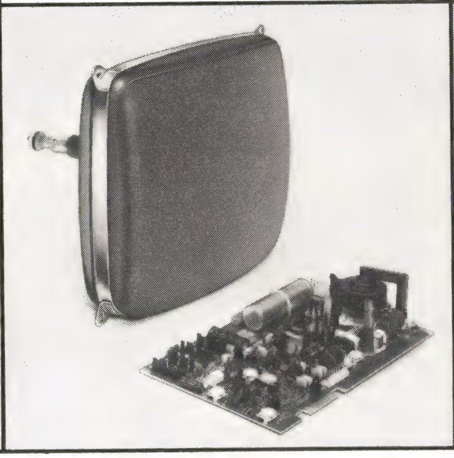	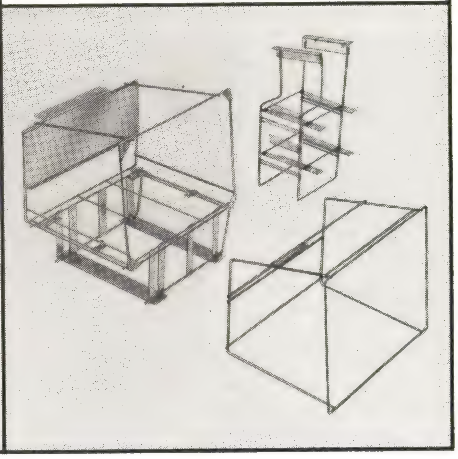

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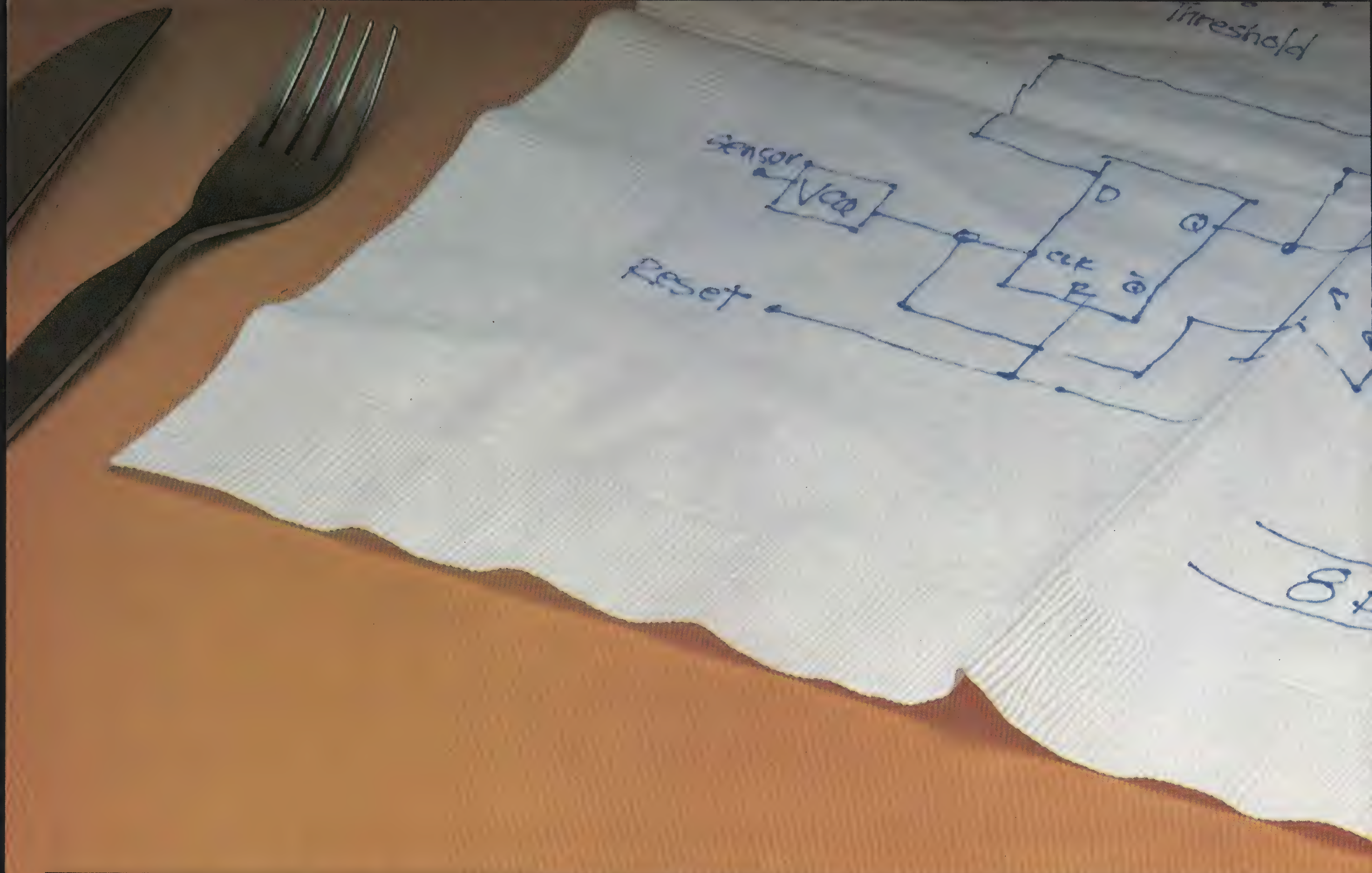

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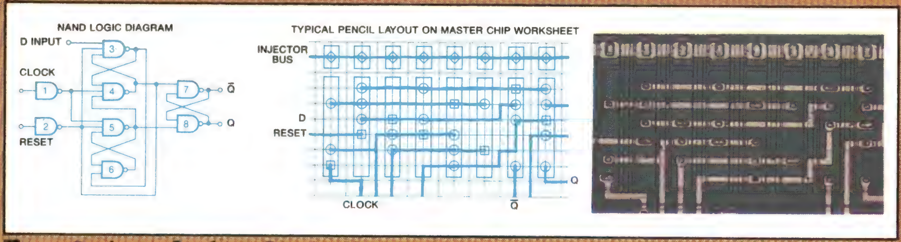

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“The trouble with it costs you an

A natural assumption. Name anything that's tailor-made for you, and you expect it to cost more than the off-the-shelf model.

Except when it comes to microcircuitry. Because in this field, you're not talking about a one-for-one replacement. With custom LSI, you usually pack one or two circuits with all the functions you need—and nothing more. (At last count, we'd put 19,000 transistors onto a single random logic custom chip). But when you're building a system with off-the-shelf components, you generally use multiple circuits that do a lot more than your product requires.

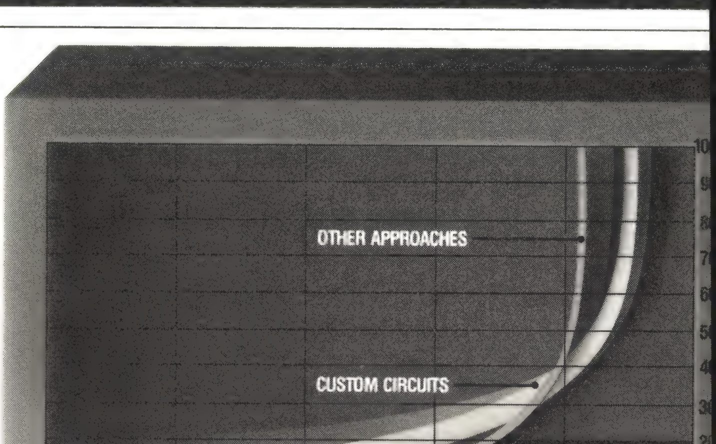
So, to get right down to the bottom line, you have to weigh all the hidden expenses. Not simply the number of parts involved. But also board space, assembly time and testing, which can run you as much as 50% of the cost of the circuits themselves. Then throw in warranty, service, spares and, for microprocessor systems, software development, and you may well discover that custom turns out to be the most cost-effective way to go.

“How do I know what's best?”

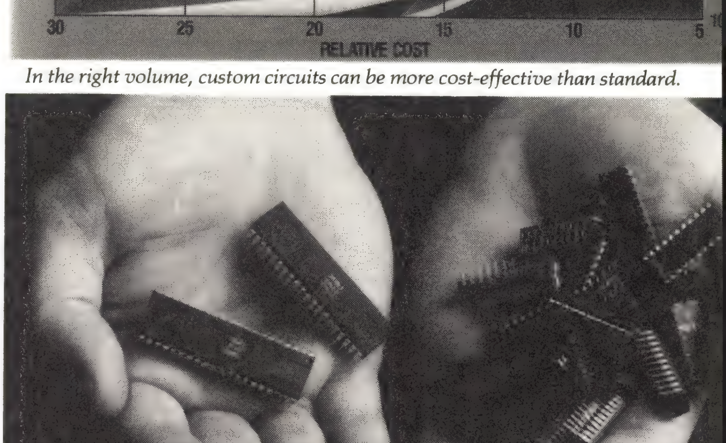
Sometimes it's hard to find out. Take your problem to half a dozen LSI companies, and you'll probably get six different solutions. That's because a few specialize only in custom. Many others only in standard. And naturally they all push their specialty.

The situation is different at AMI. Besides being the leading custom LSI company, we have a full range of standard microprocessor families—the 4-bit S2000, 8-bit S6800 and 16-bit S9900.

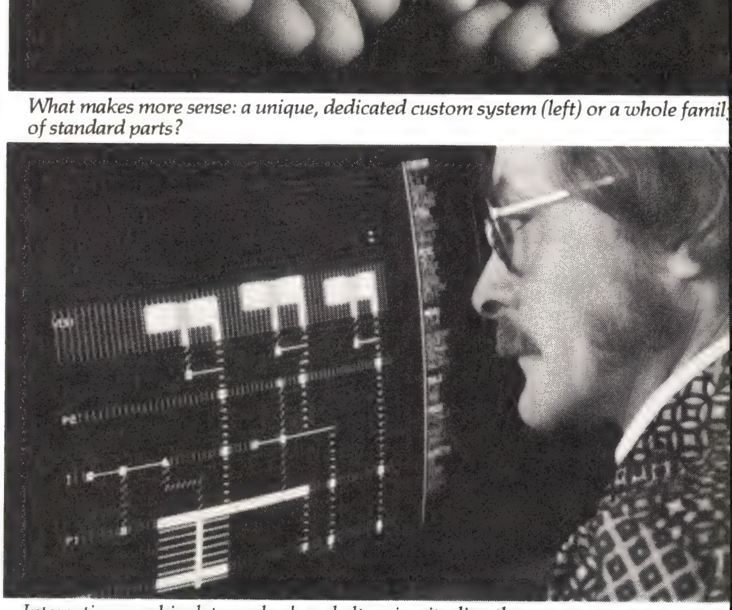
So we'll make a careful study of your application. Then recommend the best solution for you—not us. As we cover standard and custom so thoroughly, and use 25 variations of four basic MOS processes, we're not biased by any design or production limitations. We may



In the right volume, custom circuits can be more cost-effective than standard.



What makes more sense: a unique, dedicated custom system (left) or a whole famil of standard parts?



Interactive graphics lets us check and alter circuits directly on a computer.

custom LSI is that arm and a leg."

advise a pure custom design. Or a standard approach. Or a mixture of the two. In some cases, we even customize standard microprocessors.

Our only criterion is what will do the job best for the least.

"Suppose we want to design it ourselves?"

That's fine, too. Since this "customer tooled" approach is becoming more popular, we've set up a special group to handle it. In many ways, it gives you the most flexible solution. It makes sense if you have your own MOS design staff or a working relationship with an independent design house. (If you don't, we can recommend some good ones to you.) Or when you need a second source for an existing circuit.

We then become your manufacturing facility, offering so many options that we can customize a program just for you. And with plants in California, Idaho and Korea, we have plenty of production lines to handle your orders. (Some of our customers use more than a million custom circuits a year.) We even have a design center in England to help service our European clients.

Another possibility is a joint venture. We're involved with several major companies in this way, where teams from AMI and the customer work together to develop a family of products.

Whatever way you choose, you can be sure of getting the best solution in the shortest possible time. By using the very latest computer technology, we've managed to shrink the production cycle significantly. Our SLIC method (Symbolic Layout of Integrated Circuits) has reduced design time by a third. And, with interactive graphics, we can design circuits directly on a computer, eliminating the time and expense of digitizing. The result of all this is the fastest turnaround in the industry, an average of seven months from firm specification to fully tested circuit.

Want to know more? Ask for our books.

The experience of 13 years in this business (longer than anyone else) is condensed into our new brochures called "Six Steps to Success with Custom LSI" and "MOS Systems Solutions: A Dozen Case Histories Using Custom Circuits and Microprocessors."

They take you through such subjects as alternative solutions, a dozen types of processes, fabrication steps and device testing. And throw in some thought-provoking case histories to show how much ground custom LSI has covered. Your imagination will tell you how much further it can go.

So take the first step towards the success of your next product by getting hold of our books. Just write or call AMI Custom Marketing IV, 3800 Homestead Road, Santa Clara CA 95051. Phone (408) 246-0330. Or contact one of these regional sales offices: California, (213) 595-4768; Florida, (305) 830-8889; Illinois, (312) 437-6496; Indiana, (317) 773-6330; Massachusetts, (617) 762-0726; Michigan, (313) 478-9339; New York, (914) 352-5333; Pennsylvania, (215) 643-0217; Texas, (214) 231-5721; Washington, (206) 687-3101.

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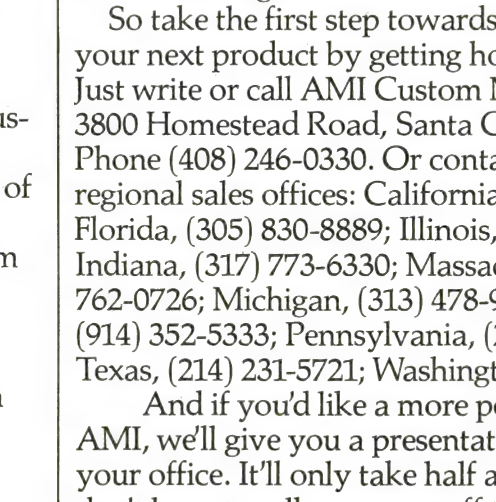

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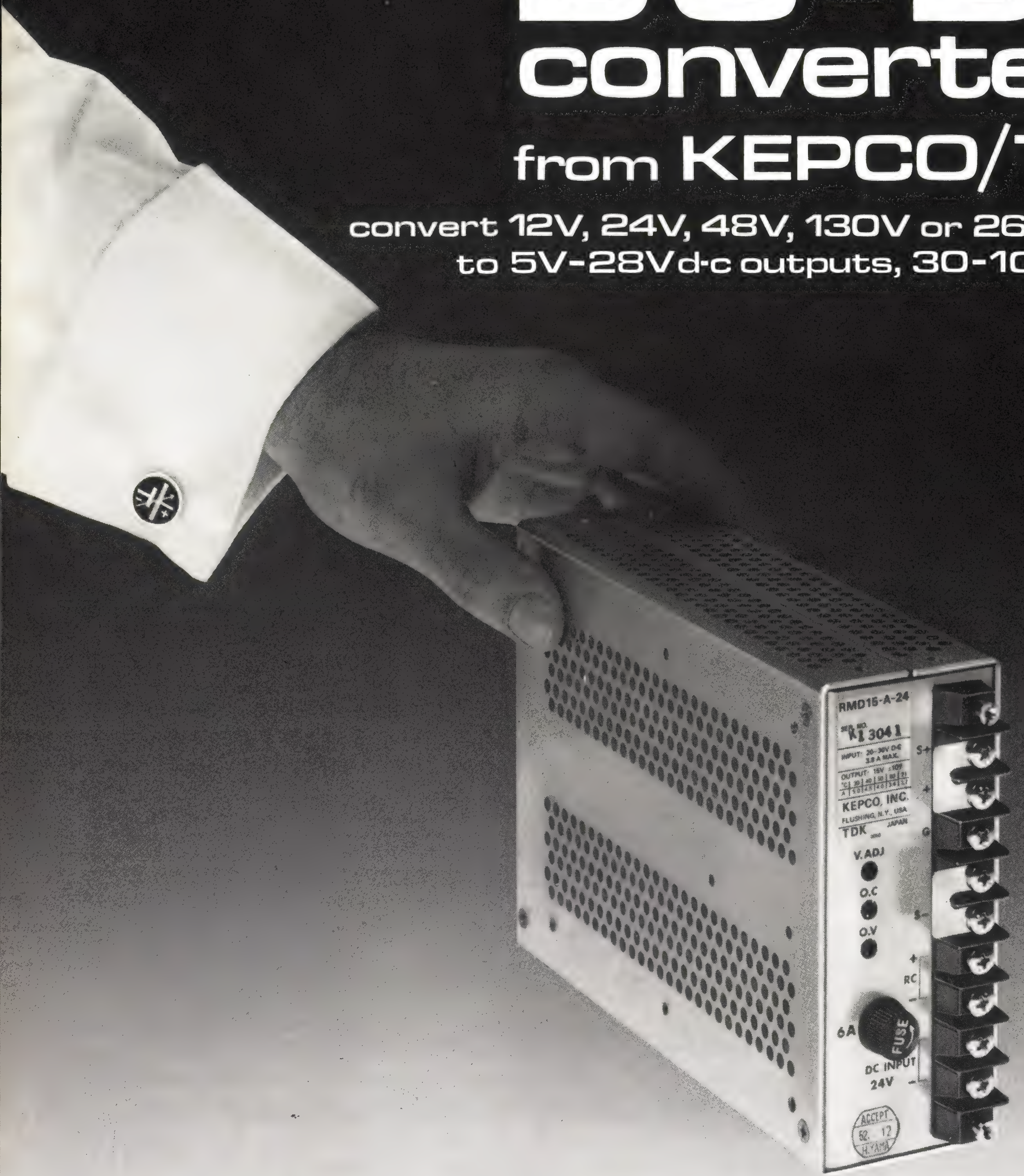

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CIRCLE NUMBER 30

IC shortage may hinder defense build-up

Notwithstanding recent international events, a security-minded Congress and President Carter's record $142.7 billion defense budget for 1981, real gains in the U.S. military arsenal may be years away. The reason: Even with huge increases in military spending, shortages of critical parts and materials—including semiconductor components—are too acute to be overcome in less than two years, and possibly longer.

Experts in and out of the Defense Department concede that the difficulties with semis and ICs are typical of shortages in other areas, such as critical metal alloys (using rare titanium, cobalt and chromium); fabricating equipment; and labor. The industry is using all of its production capacity to meet current defense-contract obligations and a booming commercial demand for its products.

Although Defense Department officials are pleased by the administration's new budget, they have been hard-pressed to spend previous authorizations, because of production delays and rapidly increasing lead times for high-technology equipment. One solution is to step up enforcement of DOD's priority systems that require military projects to be put ahead of civilian projects. Such a move could cause severe supply problems for commercial aircraft, consumer electronics and civilian heavy industry.

Space shuttle funding soars, but shuttle doesn't

President Carter's budget also gave a boost to NASA's slumping and often-delayed space shuttle project. Carter asked Congress to provide $300 million in supplemental money for the current fiscal year ending October and $1.87 billion for fiscal 1981.

Meanwhile, problems with the protective tiles used on the shuttle's surface have once again delayed the first space shuttle launch. The launch had been slated for this summer, but NASA administrator Robert Frosch predicts the first flight may be as late as early 1981.

FAA, DOT ask three firms to build computers

The Federal Aviation Administration and the U.S. Department of Transportation have awarded contracts totaling $12.8 million to three firms for the design of competitive computer systems which will automate the FAA's network of flight service stations. Ford Aerospace (Palo Alto, CA) will get $5.55 million to develop its design; Logicon (San Diego, CA) will get $3.55 million; and E-Systems Inc. (Garland, TX) will receive $3.7 million.

FAA specifications call for a system that uses off-the-shelf components and a specially designed software package. The system will store weather and aeronautical information and provide the data to FAA flight-service specialists through video-display terminals. Eventually, the system will be expanded to give pilots direct access by computer terminal and regular dial telephones.

FAA will choose one of the three systems for production, but the completion date for the development phase has not been made public. The production contract for the system could exceed $100 million, and will involve installations at the FAA's 43 busiest flight service stations.

Patent reform gets attention from lawmakers

Citing concern over a U.S. "innovation lag," the U.S. Senate intends to reform the nation's patent laws. The present inquiry ignores some fundamental questions, such as the adequacy of the current 17-year limit on patents. But one problem is getting serious attention—the role of patents in government-sponsored research and development.

The relevant bill, co-sponsored by Sens. Birch Bayh (D-IN) and Robert Dole (R-KS), would give universities and small businesses exclusive rights to inventions developed under federal research contracts. Passage of that bill by both chambers could lead to more sweeping reforms, including a unified policy on patents that would cover all agencies sponsoring research products. A Carter administration proposal would give the developer exclusive patent rights in some areas of the market and allow automatic licensing in other areas.

Present federal policies differ from agency to agency: Some permit exclusive licenses, and others require all federally sponsored inventions to be offered to any interested party, without a license fee.

NTIA supports Xerox data network

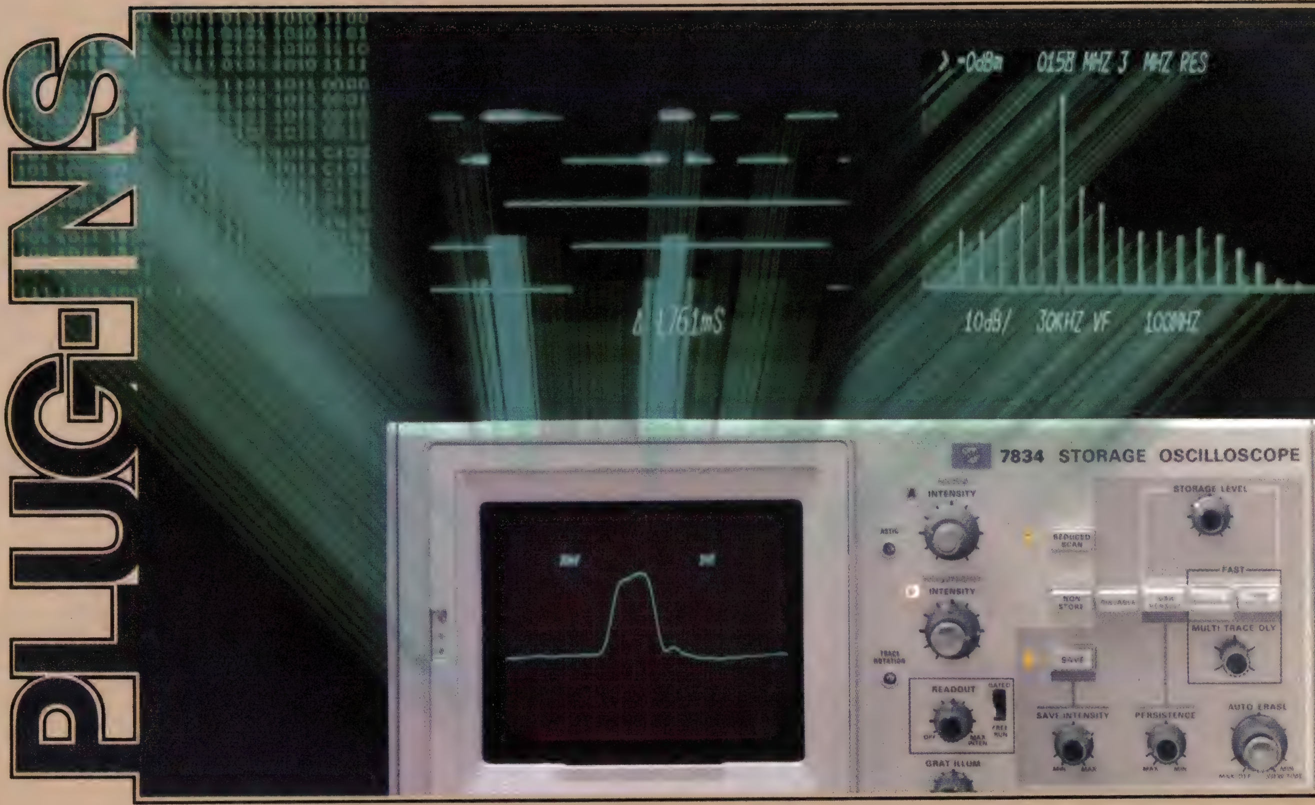
The National Telecommunications and Information Administration (NTIA) of the Commerce Department has given its "qualified" support to a plan by Xerox Corp. for a nationwide, digital, switched communications and data processing network, now pending at the Federal Communications Commission. The XTEN network, would use radio links to transmit data via satellite.

Among the criteria for NTIA support, according to NTIA head Henry Geller, are that the system should be open to regional and local customers, as well as to national firms who want to transmit data; that it should concentrate on non-voice communication at first; that Xerox's request for 100 MHz of spectrum space should be reduced to 60 MHz to leave room for competing systems; and that federal jurisdiction should be asserted over all uses of the system that involve transmission across state boundaries. Geller also urged the FCC to avoid setting up a lengthy licensing process, which might discourage competition among manufacturers in the field.

Capital capsules:

The United States is working on a guided projectile that will be fired from a high-flying fighter plane and home-in on satellites orbiting at altitudes less than 1000 miles. Reportedly, the projectile will not be armed with conventional or nuclear explosives and will have to strike its target to inflict damage . . . .**The Electronics Industries Association has unveiled a new standard** and an addendum to an existing standard. The new standard covers tests for contact bounce in electromagnetic switches. The addendum covers physical and electrical requirements for two-pin DIP packaging, designed for automatic insertion of ceramic capacitors.

FLEXIBILITY



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Product	Features
MK50981	Direct telephone line operation. Last number redial. Form A or 2-of-7 keyboard. 16-pin.
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MK50991	Direct telephone line operation. Last number redial. Mute output interfaces with bistable latching relay. 18-pin.
MK50992	Direct telephone line operation. RC oscillator for frequency reference. Last number redial. 18-pin.

MOSTEK'S TONE DIALER FAMILY

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MK5087	Direct telephone line operation. Muting and tone amplitude regulation on chip. Form A or 2-of-8 keyboard. 16-pin.
MK5089	Interfaces easily in electronic or μP dialing applications. Output tone level is a function of supply voltage. Tone Disable input. 2-of-8 keyboard. 16-pin.

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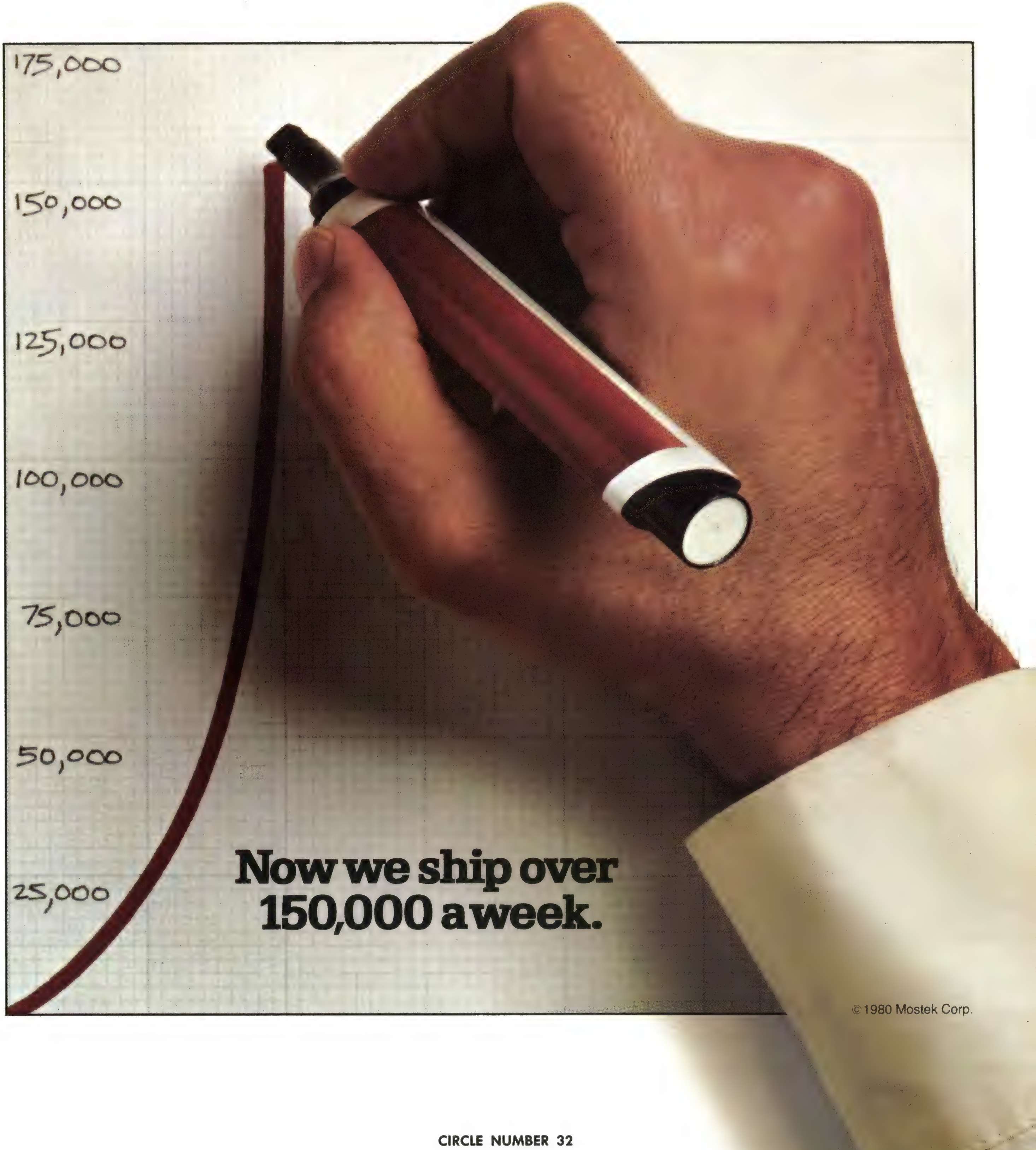

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CIRCLE NUMBER 32

Amphenol® 229 Series connectors. Qualified to MIL-C-22992, Class L. Preferred under MIL-STD-1353A.

229 Series available in cable plug and receptacle as well as wall-mount plug and receptacle (photo 1/4 size)

Positively rugged—these high-power grounded connectors are constructed with high-impact aluminum and high-strength plastic. So they'll withstand rough use. Expect far fewer replacements and less downtime than with other connectors.

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CIRCLE NUMBER 33

Salute

Italy is on the verge of modernizing and expanding its National Telephone System. Digital telephone-office switches are the keystone of the network, replacing electromechanical equipment that used space-division multiplexing of analog signals. The new all-electronic circuits are fast, reliable and line-efficient; they rely on time-division multiplexing of relatively noise-free PCM-coded digital signals. The stored programs that control the new switches will guide the phone system into a variety of special services, including meeting the nation's fledgling data-transmission requirements.

Italy's telecommunications plan will cost lots of money. Once started, a steady flow of funds must be ensured. That's why Postaltelegraph Minister, Senore Vittorino Colombo backs a novel financial approach to renewing the system: Rather than rely on subsidies, debentures or the sale of what should be a public service, he proposes to raise subscriber rates.

The rate hike Sr. Colombo proposes is sure to be unpopular. Italy's dedication to free speech, assembly and political protest—to civil liberty—is unlimited. Its national resources are not. As a result of proposals no more complex than this rate hike, individual ministries and entire governments have changed hands.

But Sr. Colombo shows less concern for the length of his term as PT minister than for his responsibility, in the classic tradition, to transmit to next generations an even greater and more beautiful homeland than his own generation received.

If U.S. politicians would exhibit similar responsibility in their stewardships, then we too might someday respond to energy, basic research and other contemporary problems with rational nationwide policies.

Sidney Adlerstein

SIDNEY ADLERSTEIN
Communications Editor

Sid Adlerstein's aggressive reporting has firmly established ELECTRONIC DESIGN as the trade magazine to watch for technology breakthroughs in communications. This year, Adlerstein's special report on ICs for telecommunications (April 12, 1979) has earned him a Jesse H. Neal award, the Oscar of the trade press. Congratulations Sid—we are very proud of you.

Lucinda Mattera, Editor

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Model 461
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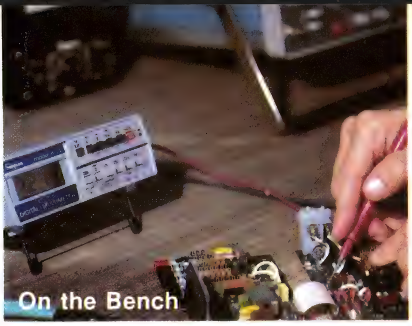

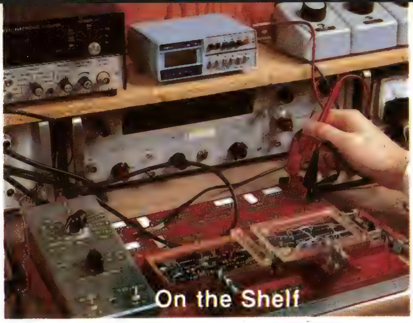

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The Popular Model 461 has large, bright .3″ LED display, 26 most needed ranges, 0.25% DC V accuracy. Gives 8 hours of continuous battery operation on a single charge. *Price includes nickel-cadmium batteries and AC charger/adapter* **$173**

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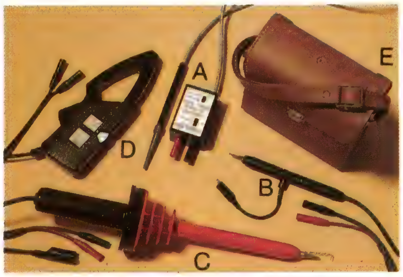

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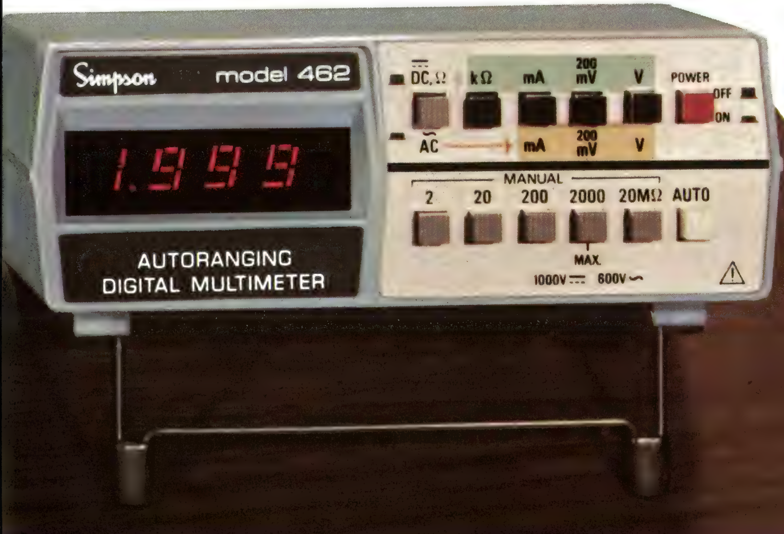

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CIRCLE NUMBER 34

IBM's thin-film heads squeeze disk capacity to record levels

The marriage of the thin-film head (which lends itself to semiconductor-like processing) and intelligent programmable controllers is changing system architecture. Thin-film recording technology will increase areal density, speed up transfers and improve reliability.

Many companies—like Storage Technology (Louisville, CO), Memorex (Santa Clara, CA) and Control Data (Minneapolis, MN)—have intelligent peripheral controllers for future film heads. An intelligent controller, such as the IBM 3880, unloads the host during multitasking operations.

Programmable, intelligent control of disk peripherals will handle most of the I/O tasking that is now being serviced by the CPU. The intelligent I/O will benefit distributed networks and interrupt-driven systems, promising better reliability and throughput.

Thin-film disk drives are being developed for plug-compatible IBM systems. One disk drive is already available from an OEM source, Burroughs Corp. (Westlake Village, CA), and tape drives will be the next peripheral to include thin-film heads. Performance of multichannel, magnetostrictive recording heads has already been measured and recorded at 5600 flux changes/mm. The read/write gaps on both disk and tape heads have been fabricated with 1-μm spaces. When the voice-coil actuators of disk drives peak out at 1000 tpi, the thin-film head will be ready to take over disk technology.

Characteristics of the IBM 3370

Areal density: 7.7 Mbits/in.^{2}
Latency (av.) : 10.1 ms
RPM: 2,964
Blocks/actuator: 558 k
Data rate: 1.859 Mbytes/s
Disk size: 14 in.
No. of disks: 7
Recoding surfaces: 12
Data transfer: 512-byte block (ID & data area)
Servo surfaces: 2

Len Yencharis
Computer and Peripherals Editor

Advances in photolithographic magnetic recording heads

Photolithographically produced magnetic recording heads offer a far greater linear recording density than conventional ferrite heads—yet require no alteration in the physical processes of disk recording. The "thin-film heads" consist of thin layers of materials deposited and shaped by techniques similar to those used in semiconductor technology. Designed for the IBM 3370 Direct Access Storage (DAS) system, the new heads provide more than double the recording density of the earlier IBM 3350, plus fast data rates, high pattern resolution and reduced flux-fringing.

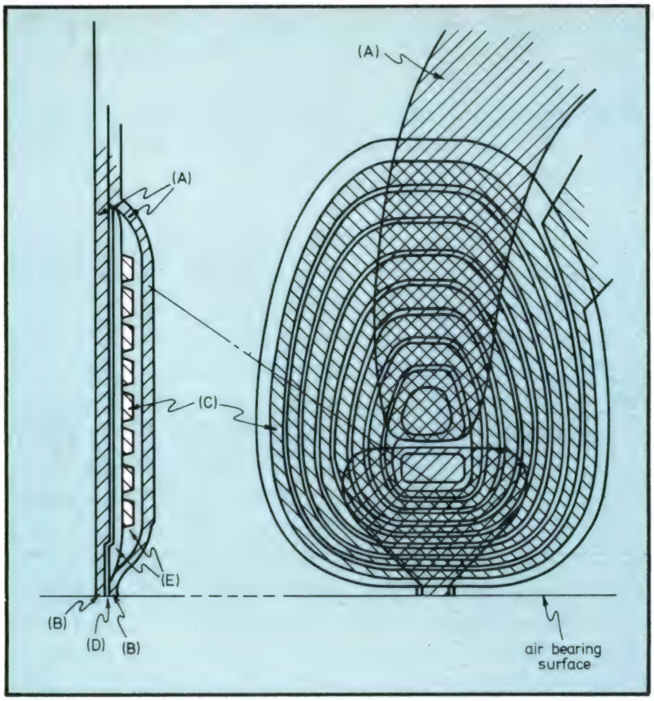
A film head consists of a slit toroid of magnetic material wound with a conductor. The conducting stripline is surrounded by permalloy film, except for the magnetic gap at the edge of the conductor. This simple design results in a single-turn head with the gap defined—and limited—by the thickness of the conductor and with the magnetic pole-tip defined by the thickness of the surrounding permalloy. The high permeability of permalloy speeds up the recording-data rate.

Design simplifies manufacturing

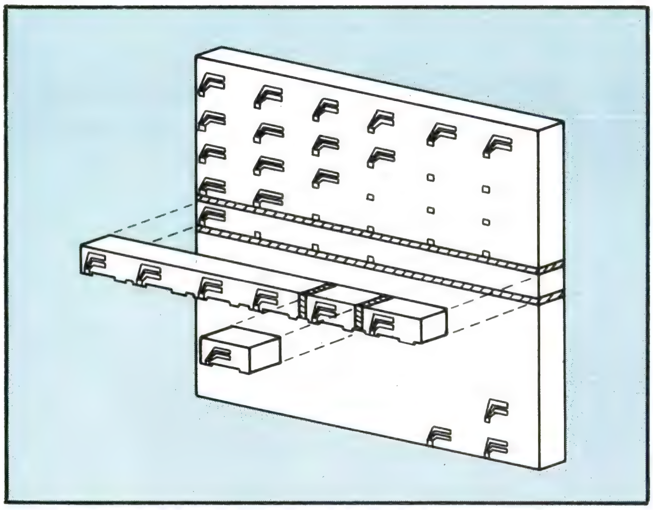
The advanced head design incorporates a planar-spiral conductor winding, which is recessed away from the air-bearing surface (Fig. 1). With this design:

- The current required for writing is reduced. Integrated circuits can be used to supply the write current.
- Manufacturing is simplified; the precision of film photolithography creates well-defined pole-tip geometries.
- The head gap is formed independently by a deposited nonmagnetic insulating film.

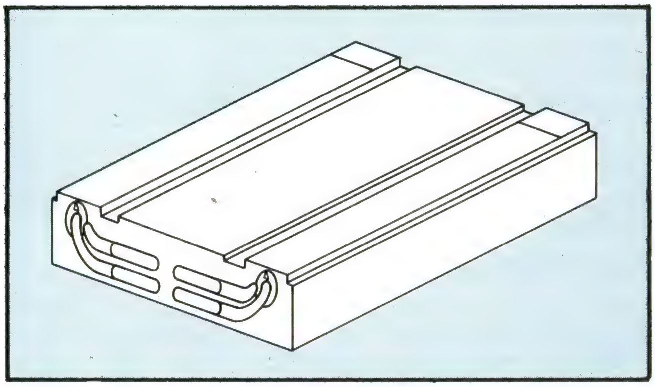
The conductor-spiral, permalloy yoke and pole tips are all fabricated by electroplating through a photoresist mask. This process yields the desired pattern and edge definition, and relatively thick, narrow lines can be formed to give an efficient, low-



1. The integral components of the film head include: the magnetic layers (a), pole tips (b), conductor turns (c), gap layer (d) and insulation layers (e).



2. The film head substrate is first parted into rows and then lapped to a final throat height with a double-rail air bearing. The substrate is then diced into separate sliders.



3. Double-rail film head sliders that contain the magnetic element are made from single substrate wafers.

resistance multiturn coil.

Two conflicting criteria are encompassed in the head design. Efficient writing and reading of data call for widely separated, thick, permalloy legs. However, high recording resolution is maintained with thin permalloy separated by a narrow gap. Therefore, thin permalloy and film gaps are implemented in the pole-tip region, and thicker permalloy films with thicker insulation are used in the yoke area of the head, away from the pole-tip region. Thickness is determined by selecting the smallest dimensions consistent with avoiding magnetic saturation of the pole tip and excessive flux leakage through the gap during writing.

Wafers hold several elements

Many thin-film head elements are processed by film deposition and photolithographic steps on a single substrate wafer (Fig. 2). These wafers can be diced and machined to yield individual hydrodynamic sliders, which contain the magnetic element on the slider's trailing edge.

This technique lends itself to batch wafer processing and dicing, similar to LSI techniques, and eliminates the bonding of individual head elements to separately fabricated sliders.

Air-bearing support of a magnetic recording head

High areal-density magnetic recording depends partially on the use of film technology for the read/write elements. The other essential factor is the maintenance of a nearly constant space between the elements and the spinning magnetic disk surface. In the IBM 3370 Direct Access Storage (DAS) system, this "flying height" of the recording head is held at approximately a half-wavelength of visible light.

A self-acting, air-lubricated slider bearing supports the magnetic recording head (mounted on the slider) over the rotating disk surface. "Self-acting" indicates that the shape of the slider allows an air film to be established between the slider and disk at the required bearing pressure (Fig. 4).

The slider is designed with reference to:

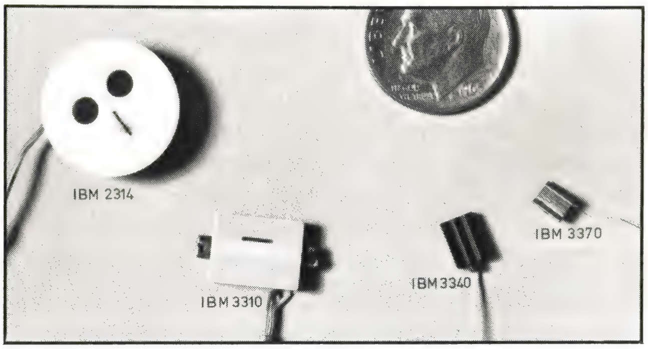
- The size and shape of the air-bearing surface
- The magnitude of the applied load
- The magnetic requirements of the disk recording subsystem
- The allowable manufacturing tolerances.

The flying height (the distance between the heads and the disk surface) and its allowable variations are governed by the need for mechanical reliability, as well as by magnetic requirements. The maintenance of spacing during file operation requires: a flat, smooth, recording surface; exceptional stiffness in the air bearing; and a low-inertia slider suspension. Also, the slider suspension system must damp out resonant frequencies, or at least remove them from the normal operational excitation frequencies.

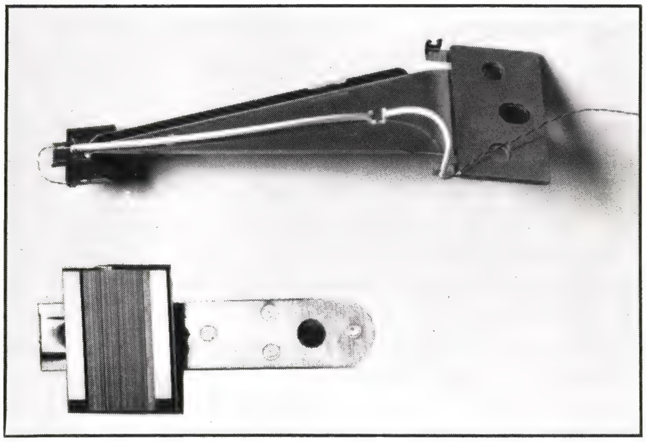
The IBM 3370 slider is a two-rail, taper-flat design, supported by a leaf-spring suspension (Fig. 5). The 3370 air-bearing is three times stiffer than that of the IBM 3340 and 3350 series; and the effective mass of the slider-suspension system is about one-fourth that of the IBM 3350. Even though the disk surface may move vertically several thousandths of an inch, the slider follows these excursions and maintains its flying height well within a microinch. The reliability and performance of the slider reflect the contributions of engineering, theoretical analysis and computer modeling.

Suspension keeps slider positioned

The leaf-spring suspension that supports the IBM 3370 slider over the disk surface gives it freedom of motion in the vertical direction, as well as rotational motion about the pitch and roll axes, but restrains all other motions. The flying height and pitch angle of the slider are determined both by the magnitude of the suspension loading force and by the geometry of the system.



4. The 3370 slider is much more compact than other IBM disk products.



5. The slider-suspension assembly of the 3370 is a two-rail, taper-flat design supported by a leaf-spring suspension. The close-up shows the slider surface.

The design process for the slider-suspension system is greatly facilitated by computer modeling and simulation. The geometry of the slider air-bearing is determined with a computer program that solves the Reynolds gas lubrication equation for the pressure distribution in the air-bearing. The flying height, pitch and roll angles are calculated so that the forces and moments caused by the bearing pressure are balanced by the applied forces and moments of the suspension.

The flying height changes as the slider is accessed from the inner radius to the outer radius of its data band. The curve for this variation is generated by varying the disk velocity in the computer simulation. Magnetic recording requirements govern the spacing allowed to deal with this effect.

Interferometer laboratory tests and measurements verify the slider design: A slider is flown on the surface of a glass disk, while the lubricating air film is illuminated with white light. The colored interference pattern that results is interpreted through a microscope.

Modeling describes spacing variations

Irregularities in the disk surface and external vibrations lead to forced motions that can cause variations in the dynamic spacing between the head and the disk. Although unavoidable, these conditions can be anticipated through modeling, using a simulation program, which solves the Reynolds equation, and a transient model of the suspension. Derived from an analysis using NASTRAN programs, the model is verified by holographic measurements of its response to a known excitation.

The program computes the fundamental vibration modes of the air-bearing and suspension systems, as they respond to impulses in the vertical and pitch-and-roll directions; and can also compute responses to various inputs from the disk, such as bumps and ripples. As verification of the results generated by the model, the variations are measured in terms of electrical capacitance changes between the slider and disk during operation: The changes in capacitance are proportional to the spacing variations.

Design considerations for data integrity

When a disk system transfers data at extremely high rates, error correcting codes (ECC) can be processed in serial-by-byte form instead of serial-by-bit. The high transfer rates and fixed-block architecture of the IBM 3370 necessitated new methods for detecting, correcting, and preventing data errors:

- ECC, with 9 bytes appended to the end of each data field to detect errors and correct information
- ECC circuitry to check the validity of the block-identifier field (ID), which is written in front of each data block
- Alternate block and move IDs to compensate for surface defects on the disk
- Seek verification to prevent reading or writing an incorrect area of the disk.

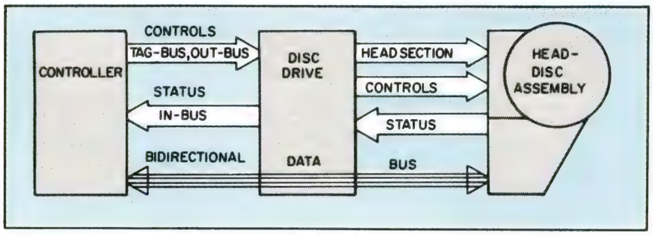
Because of its fixed-block format, the 3370 can use look-up tables in the controller microcode to create overlay patterns of displacement and correction. This method is faster and less costly than any of the hardware methods.

The ECC detects and corrects errors following the reading of a data field from the drive. The 9 bytes appended to the end of each field detect a single-burst error as long as 16 bits and correct a single-burst error as long as 9 bits. The ECC circuitry checks the validity of the ID field by means of 3 bytes of error-detection-only information appended to the end of each field. Errors in the ID field are detected during either a read data operation or a write data operation.

Another method of providing data integrity in the controller is to bypass small surface defects on the magnetic disks. Whenever a surface defect occurs in an area where information is to be stored, the block containing the defect is flagged in its ID field, and an alternate block is assigned in its place. A portion of each cylinder is reserved for use as alternate blocks.

Any unused alternate block on a disk cylinder is available for assignment to any other cylinder that has exhausted its alternate blocks.

With seek verification, no read or write data operation can take place until the ID field of the block to be processed is compared to the argument transmitted from the storage control. If the "compare" is not successful, a miscompare is indicated to the storage control, which discontinues the operation.



6. In the 3370 subsystem, data and control paths are outside the drive and must be monitored for a successful data transfer.

Successful transfer

Certain drive conditions must be monitored before and during a transfer of data to ensure a successful operation:

- The servo must be in a track-following mode.
- The read-only switch cannot be on when a write is attempted.
- The dual out-bus bits and the dual write gates must be operating in unison.
- Illegal commands (such as simultaneous read and write) cannot be used.
- Architectural boundaries (such as fixed-block delimiters) may not be violated.

For successful data transfer, read/write data pass through the drive unchecked—checking is handled by the error-correction code in the controller. However, the read/write control lines are monitored by the drive to ensure that the head-disk assembly (HDA) correctly receives the commands sent by the controller (Fig. 6).

The tag-bus and out-bus commands are parity checked at the drive, and the write command structure contains redundant bits for safety. A dual write gate ensures that writing cannot take place unless both gates are present. No bit or gate can be stuck, either up or down, without being detected at some point during the data transfer; and no single component failure in the write control logic can cause permanent loss of data.

The drive also monitors the control lines from the HDA, using the status bits provided by the arm-electronic modules resident in the head-disk assembly. Checks can be made when the file is being deselected. If a condition arises in the HDA electronics which is indicative of head current, an error latch is set to flag the system at the next drive select time.

During the data transfer, the status lines indicate many conditions relating to open lines and malfunctioning circuits in the HDA; for example, whether write data are present at the head, whether a single head is selected or whether the head is in read or write mode. The arm electronics also has built-in self-checking. ■■

The following staff members from IBM's Development Laboratory, GPD San Jose, CA, contributed to this article: recording heads—Ian M. Croll and Robert E. Jones, Jr.; air-bearing support—Sandy Bolasna, Senior Associate Programmer, Ken Deckert, Advisory Programmer, Mike Garnier, Advisory Engineer, and Bob Watrous, Advisory Engineer; data integrity—Paul L. Shaffner, Senior Associate Engineer, and John W. Hughes, Staff Engineer.

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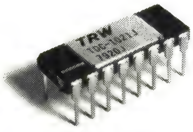

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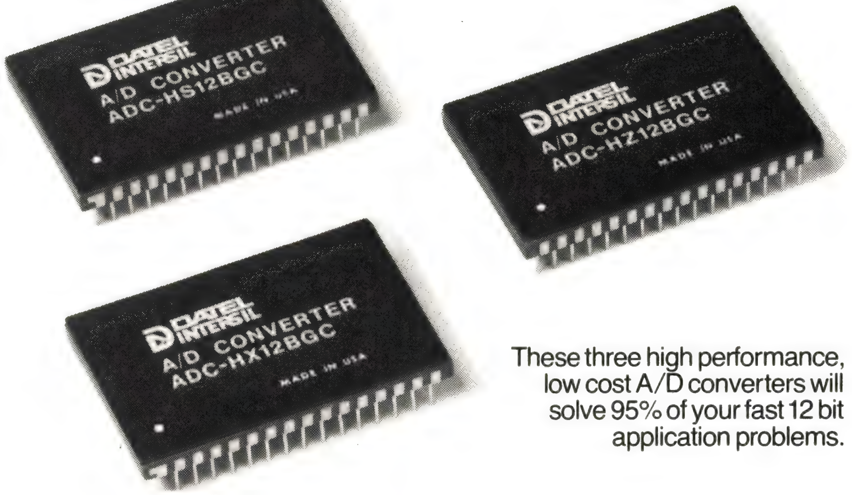

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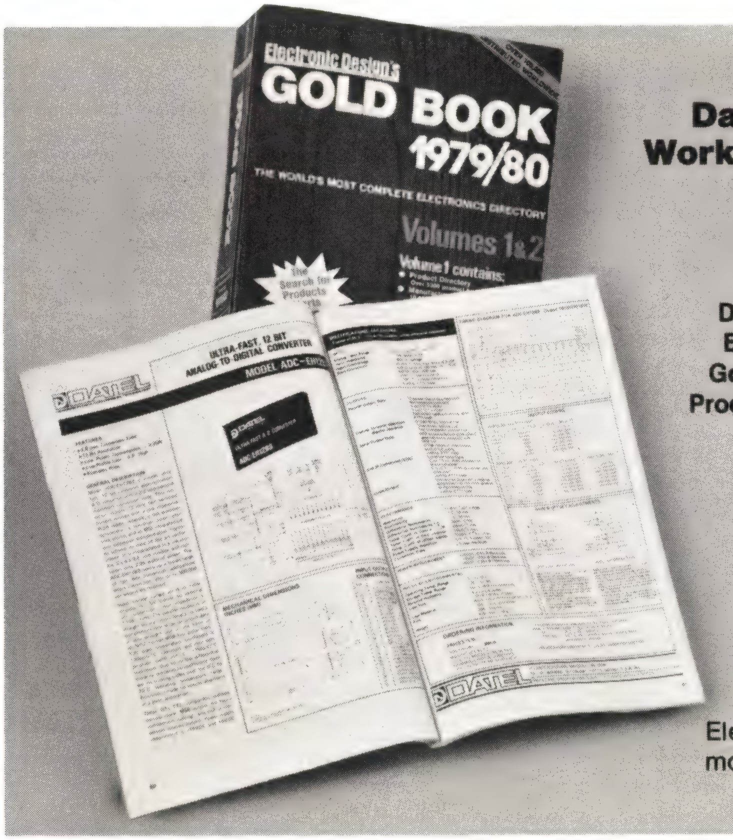
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CIRCLE NUMBER 37

Miniaturized, high-speed, EMI-proof optical links fill the bill in computer systems

Fiber-optic advantages over wire transmission in weight, bulk and performance have been enough to spur development for military and telecommunications uses. But recently developed packaging and related semiconductor innovations will be the catalyst for the bigger role fiber-optic interconnections will play in commercial computer systems. For such equipment, technical advantages simply are not enough—availability, manufacturability and cost effectiveness count just as heavily. Fiber optics offers three features that should prove attractive for commercial computer equipment:

- Miniaturization
- Higher data rates over longer distances than available with coaxial connections
- Reduction of electromagnetic interference (EMI).

Shrinking circuits via LSI has spawned distributed processing, which in turn is spurring the need for improved high-speed, long-distance interconnections. The problem is, standard wire transmission is now delivering about all the performance that can be expected, especially in the input/output (I/O) area. Fortunately, the higher bandwidth and lower attenuation of fiber-optic transmission systems spell higher data rates and longer-distance transmission—using less hardware.

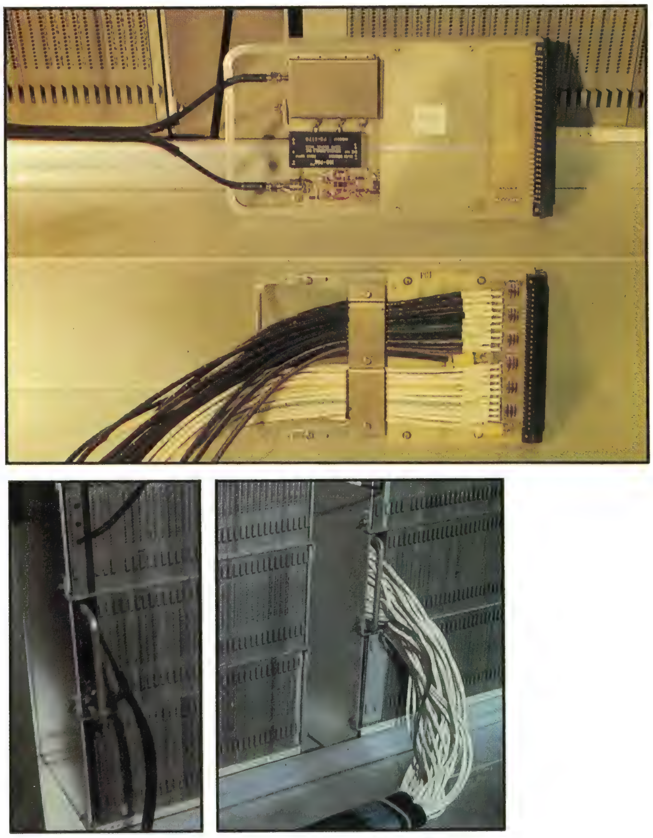
Fig. 1 graphically depicts the level of size reduction that fiber optics can bring. The two-fiber cable shown has a demonstrated information-carrying capability greater than the bundled coaxial system.

EMI is more than simply a technical concern for computer-equipment designers. Regulations for EMI emanations are becoming stricter for computer equipment used in the U.S., Canada and West Germany, among other countries. Fiber-optic cables do not radiate nor are they susceptible to EMI. Since intercabinet cabling contributes significantly to EMI emanations, fiber-optic replacements make sense.

The financial angle

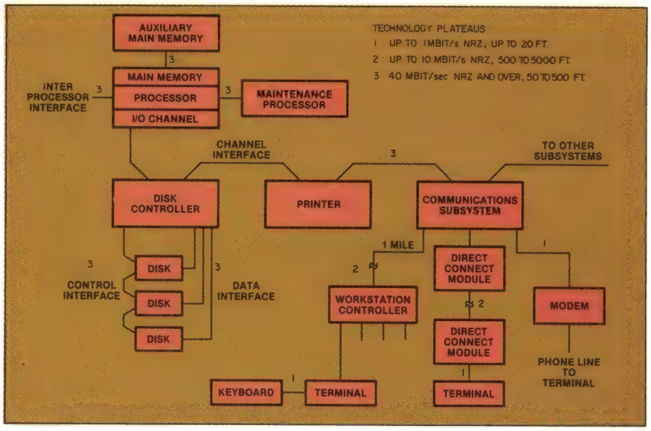
Where can fiber optics bring economical as well as performance benefits to commercial computers? Check the block diagram of Fig. 2, which describes a typical system configuration using standard wire technology. The interconnections divide conveniently into intracabinet connections, intercabinet connections and intersite connections.

Intracabinet connections, such as processor-to-main-memory or processor-to-I/O-channel controllers, are not likely candidates for fiber optics. Since these runs usually connect short-distance, high-speed, highly structured parallel interfaces, the full advantages of fiber-optic interconnection cannot be realized, and therefore would not be cost-effective.

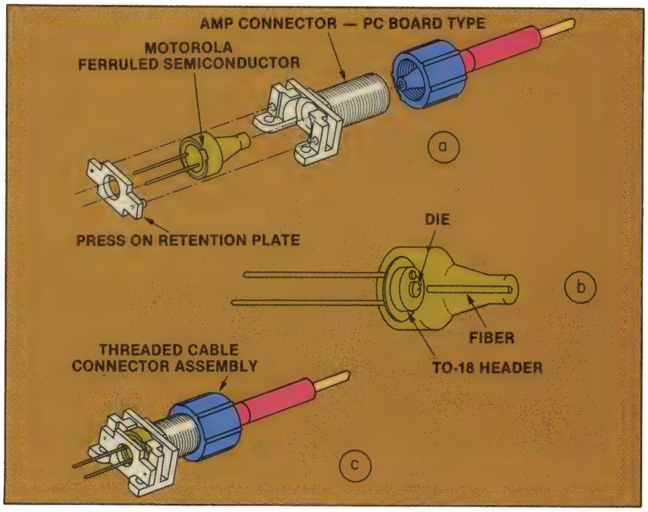


1. Fiber-optic vs coaxial: Even though it packs an LED, its driver, a complete optoelectronic receiver and dc-to-dc converters for required supply voltages, the fiber-optic board is better suited for PC-board construction than its pin-compatible coaxial-cable counterpart (above). The cabling advantages of the optical transmission system are obvious in the side-by-side installation of coaxial and fiber-optic controllers (below).

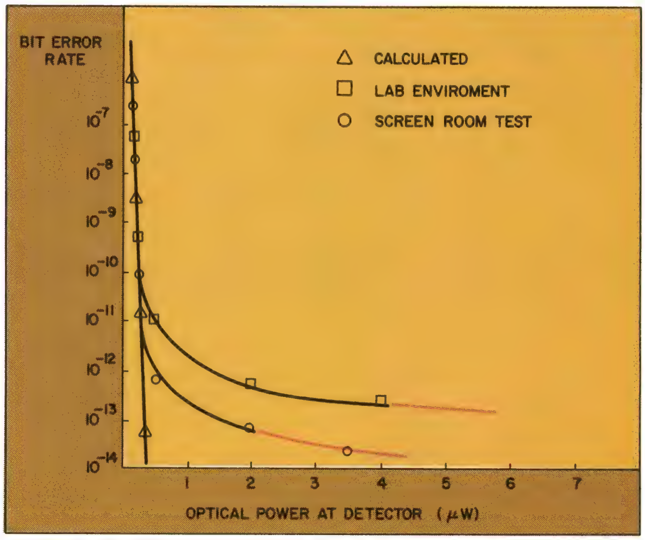
R. Kirk Moulton, Principal Engineer, Technology Development, Sperry Univac, P.O. Box 500, Blue Bell, PA 19424.



2. Interconnections in a typical computer system divide into intracabinet, intercabinet and intersite links. Fiber-optic transmission can cost less than wire for intercabinet and intersite cabling runs.


AMP CONNECTOR — PC BOARD TYPE
MOTOROLA FERRULED SEMICONDUCTOR
a
PRESS ON RETENTION PLATE
DIE
b
FIBER
TO-18 HEADER
THREADED CABLE CONNECTOR ASSEMBLY
c

3. Ferruled semiconductors integral to fiber connectors are AMP and Motorola's solution to the fiber-to-semi connection problem. AMP's connector (a) holds a semiconductor emitter or detector already placed in its plastic ferrule by Motorola (b). The assembled unit leaves room for the normal PC-board commonly used spacing in commercial computers (c).



4. Bit-error rate hinges on the detected optical power level in systems using pin-diode detectors.

However, fibers can economically compete with wire for intercabinet and intersite runs. One way to boost cost effectiveness is to replace a parallel, coaxial-wire system with serial, fiber-optic transmission.

As Fig. 2 also shows, there are three bandwidth-distance target ranges suitable for fiber-optic links. One range, corresponding to the lowest data-rate × distance product is for links shorter than 20 ft with rates up to 1 Mbit/s,NRZ. Examples include keyboard-to-terminal interfaces and other hookups in which static discharge is a major concern. A second, or intermediate, plateau covers 500 to 5000-ft links that carry data at up to 10 Mbits/s,NRZ. These figure in printers, terminals and remote work stations and their controllers.

However, fiber optics makes the most telling impact on the third—and most demanding—data-rate × distance level: 50 to 500-ft links handling data rates up to 40 Mbits/s and over. With fiber optics, such serial links can achieve true data-transfer rates of over 4 Mbytes/s between processors and auxiliary main memory, processors and controllers, and controllers and high-speed devices like disk drives. At best, the standard, parallel, coaxial circuits used in this range are limited to 2.5 Mbytes/s at about 200 ft or less.

Other considerations

But as Fig. 2 further shows, intercabinet and intersite interfaces require different performance levels. Packaging and PC-construction requirements also vary from system to system. Therefore, both the electronics and support logic must be tailored to each application's cost and performance objectives. In addition, there is a two-edged requirement: Considerable flexibility must be designed into fiber-optic interface hardware to accommodate future I/O devices; but for reliability as well as low-cost manufacturability, standardization of components is also needed.

While many connectors align two fibers well enough, coupling fibers to source or detector semiconductors is another matter. For example, mounting an electro-optical semiconductor source or detector in a windowed or lensed TO-18 often falls short for two reasons: Optical efficiency is low (Spectronics' Sweet Spot is a notable exception); and the tight mechanical tolerances needed are not practical for PC-board component assembly.

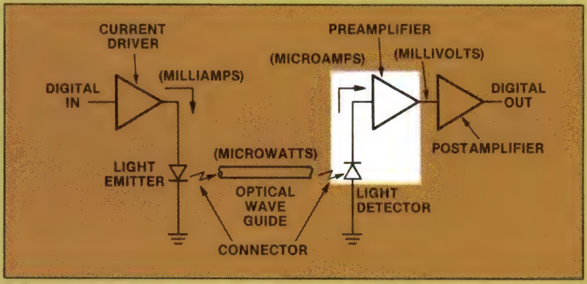
The optical-efficiency problem can be solved by pigtailing—attaching a short length of cable, say 10 cm, directly to the semiconductor. A standard connector terminates the other end. All the user has to do is terminate his cable with the mating connector. With the semiconductor manufacturer performing the delicate alignment between device and cable, he can then guarantee optical performance.

There are also drawbacks with the *flexible* optical pigtail as described. Several flexible-pigtailed semiconductors are somewhat unwieldy and bulky as well as vulnerable to damage during PC-board component

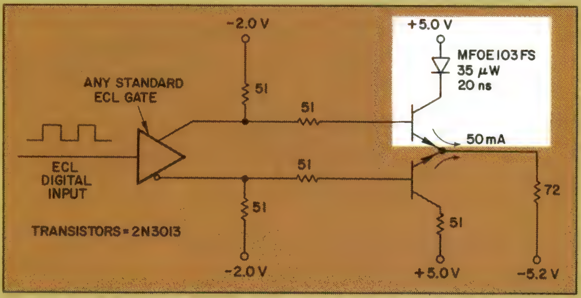
An easy link

A digital fiber-optic link for commercial computers is simple to depict (see building blocks in the figure below) and almost as easy to follow.

First, the digital voltage signal is converted into an equivalent current, which in turn generates a corresponding wave of radiant energy (light). The light is coupled into the optical-fiber waveguide through a connector and transmitted down the fiber. At the receiving end, the departing light is coupled through a connector into a detector. The detector converts the light into low-level current (μA), which is then amplified and transformed usually in two stages, back into logic-level signals.



For sources, LEDs are usually preferred to lasers in computers. While lasers offer higher data rates, LEDs offer longer life, lower-voltage operation and lower cost. In addition, LEDs have relatively simple drive requirements, which are easily rendered into circuitry. The LED driver circuit shown in the right figure is complete and fully operational. Note that other LED drivers such as TTL-compatible circuits are just as simple.



The driver switches 50 mA on and off with rise and fall times under 5 ns. The LED in this circuit, a Motorola MF0E103F FOAC, typically switches in 20 ns and launches 35 μW of optical power, centered about 910 nm, into its fiber.

For speedier links, the TXES-491 LED from TI switches with 6-ns typical rise or fall times at 850 nm. At a 50-mA drive, this LED launches about the same optical power into an 8-mil fiber as the Motorola LED. For longer-distance links the SE3352-03 LED from Spectronics typically launches 200 μW into an 8-mil fiber at a 50-mA drive. Spectronics' LED switches somewhat slower than TI's—12 ns at 820 nm.

The optical output for all three LEDs just about doubles when the drive is doubled to 100 mA.

Most commercial-computer interfaces could be implemented in fiber optics if LEDs like the 491 and 3352 were integrated into FOAC-type connectors.

Receivers, however, are more demanding. Typical designs use discrete detector, preamplifier and postamplifier elements. However, the error rates of these discrete designs are too high for most computer applications. An acceptable error rate depends heavily on reduced sensitivity to EMI pickup, as in a fiber-optic receiver that uses an MF0D403F monolithic detector preamplifier along with a simple 10116 postamplifier.

assembly. Moreover, flexible pigtails are subject to severe flexure and impact stresses that can damage the expensive parts they couple.

A joint approach by Motorola and AMP could well solve the fiber-to-semi connection problem. Fig. 3a shows how AMP's Optimate fiber-optic connectors directly hold Motorola's Fiber Optic Active Connector (FOAC) devices (Fig. 3b), which make up a family of plastic-ferrule-mounted semiconductors. Not only is the resulting assembled connection rugged (Fig. 3c), but its 0.3-in. height is compatible with the typical 0.5-in. spacing of PC cards in commercial computers. A *rigid* fiber pigtail joins the semi's active area and the highly polished ferrule.

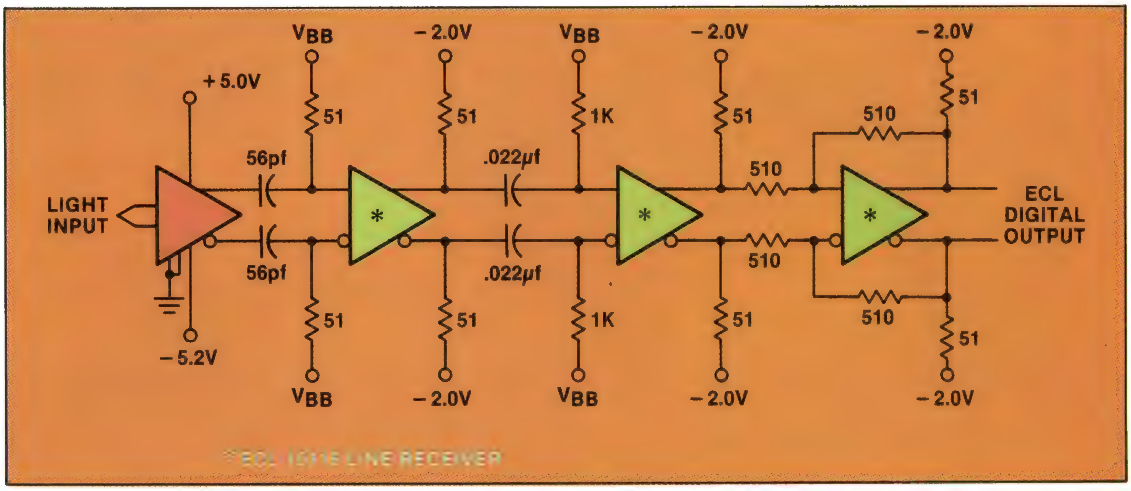
Although fiber-optic cables are immune to EMI, most fiber-optic receivers are not. As in any high-gain high-impedance amplifier, EMI pickup at the input node is a potential problem. In the case of a fiber-optic receiver, this problem is greatest at the node joining the detector and the preamplifier.

Goodbye EMI susceptibility

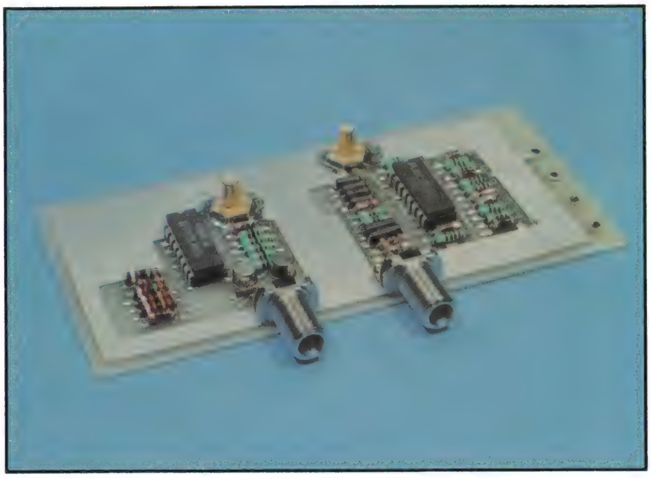
Fig. 4 shows that systems using discrete pin diodes cannot adequately control bit-error rate by simply increasing optical power. Furthermore, heavy shielding or additional shortening of this critical node is not economically practical.

Bear in mind that the bit-error rates (BERs) for high-speed I/O devices like disk drives are typically one error in 10^9 or 10^{10} bits. Hence, an acceptable interface error rate must be much better—say one error in 10^{13}. Curves for error-rate performance in a lab environment show the futility of aiming for such a low BER using standard pin-diode detection.

A monolithic detector preamplifier IC like



5. High gain from the detector chip allows a simple postamplifier to complete this fiber-optic receiver. This version differentiates the IC's output, putting the information into a pulse train.



6. One PC board easily holds both the transmitter (left) and receiver (right) for a 25-Mbit/s NRZ fiber-optic link. Each section is an obvious target for further integration.

Motorola's MF0D403F is the solution. It includes both a high-speed detector and a preamplifier (ELECTRONIC DESIGN, Oct. 11, 1979, p. 29), and fits into the Optimate connector. Besides offering the mechanical advantages of the FOAC family, this monolithic member offers virtual immunity to EMI (the critical node is shorter), and external loading effects. Moreover, it delivers typical rise and fall times of 12 ns and total gains of 8000 V/W.

Gain helps

The high gain simplifies receiver post-amplifier design. Fig. 5 shows a fully operational receiver that uses the MF0D403F. This circuit differentiates the signal from the detector IC to capture the information content on the pulse-train edges. The R-C differentiator's time constant must be compatible with the total system rise time. In this case, the 200 pF and 50 Ω match the resultant system rise time at the detector-preamplifier outputs. To ensure a low error rate, the total gain is tailored for a 16:1 signal-to-noise margin. The final stage of the receiver is an RS flip-flop that restores the dc signal. All the post-amplification needed is provided by one 10116 ECL device.

Figure 6 shows a printed-circuit board version of the electronics for a fiber-optic link. Both the receiver electronics and the driving circuitry for the LED are included. The link can operate at data rates up to 25 Mbits/s, using non-return-to ZERO coding. Obviously, integrating this or similar circuitry could reduce the size of the link electronics while simultaneously speeding up the data rate.▪▪

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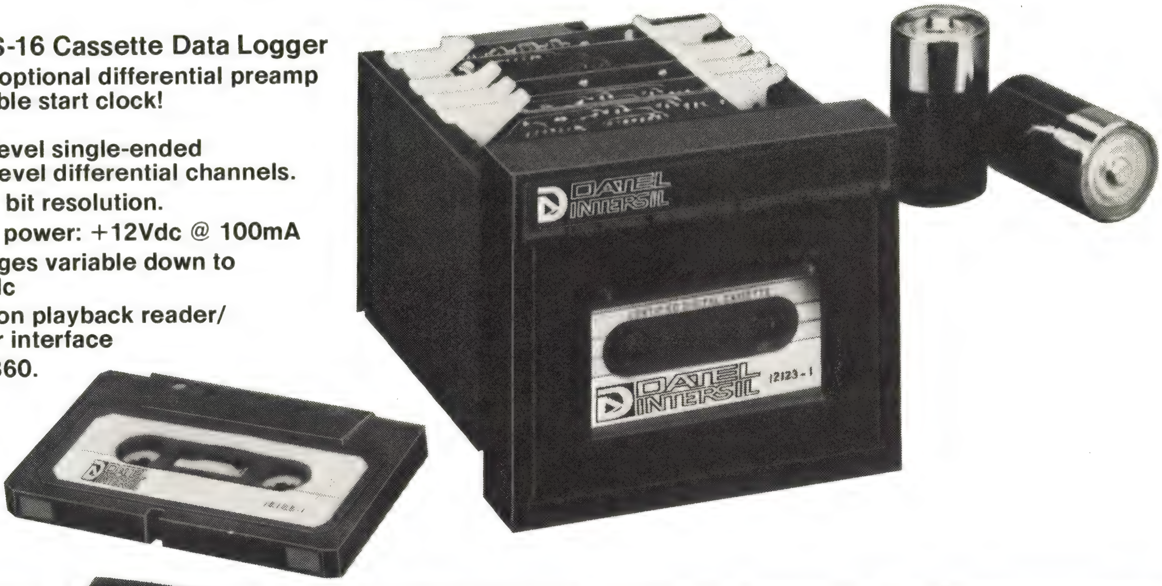

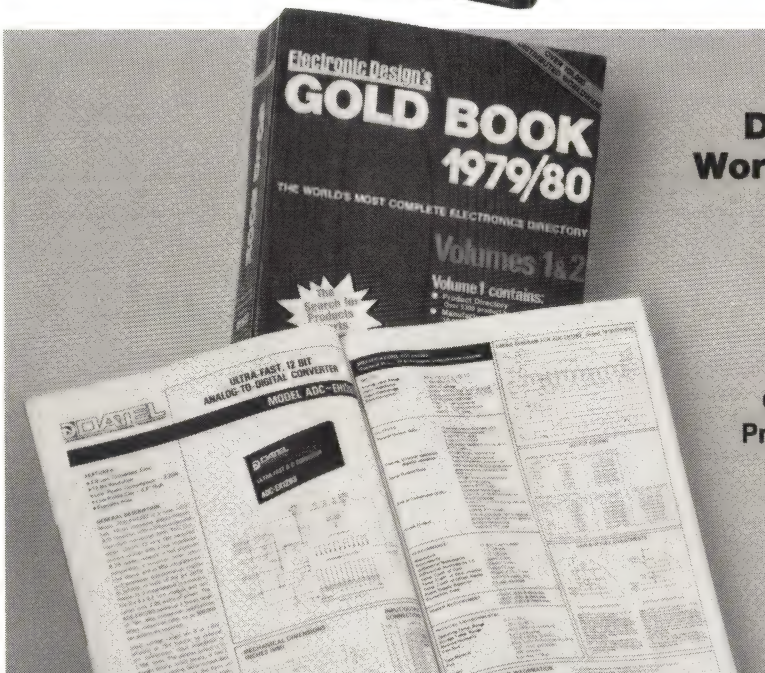
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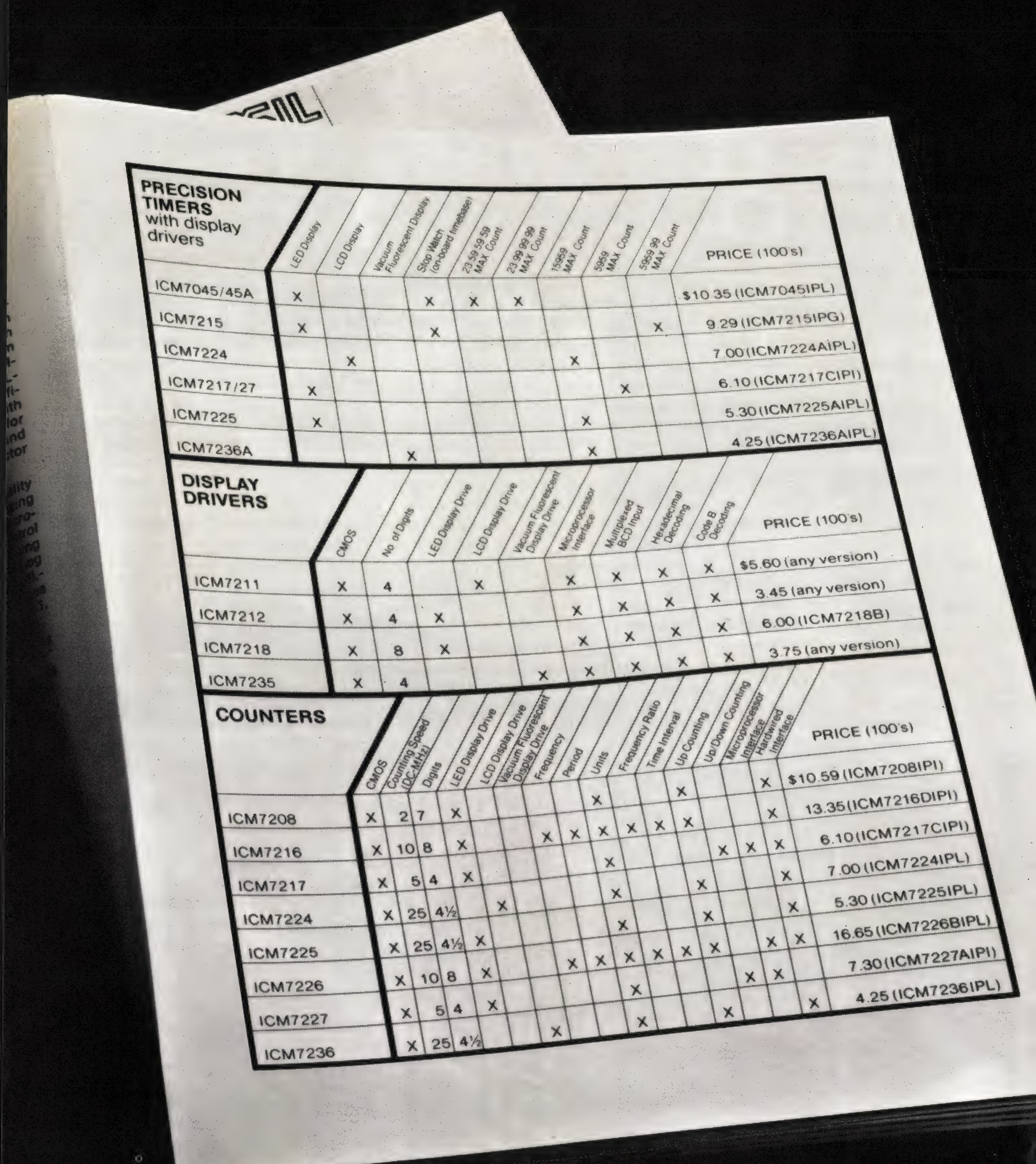

PRECISION TIMERS with display drivers	LED Display	LCD Display	Vacuum Fluorescent Display	Stop Watch (on-board timebase)	23 59 59 59 MAX Count	23 99 99 99 MAX Count	1959 MAX Count	5959 MAX Count	5959 99 MAX Count	PRICE (100's)
ICM7045/45A	X			X	X	X				$10.35 (ICM7045IPL)
ICM7215	X			X					X	9.29 (ICM7215IPG)
ICM7224		X					X			7.00 (ICM7224AIPL)
ICM7217/27	X							X		6.10 (ICM7217CIPI)
ICM7225	X						X			5.30 (ICM7225AIPL)
ICM7236A			X				X			4.25 (ICM7236AIPL)

DISPLAY DRIVERS	CMOS	No of Digits	LED Display Drive	LCD Display Drive	Vacuum Fluorescent Display Drive	Microprocessor Interface	Multiplexed BCD Input	Hexadecimal Decoding	Code B Decoding	PRICE (100's)
ICM7211	X	4		X		X	X	X	X	$5.60 (any version)
ICM7212	X	4	X			X	X	X	X	3.45 (any version)
ICM7218	X	8	X			X	X	X	X	6.00 (ICM7218B)
ICM7235	X	4			X	X	X	X	X	3.75 (any version)

COUNTERS	CMOS	Counting Speed (DC-MHz)	Digits	LED Display Drive	LCD Display Drive	Vacuum Fluorescent Display Drive	Frequency	Period	Units	Frequency Ratio	Time Interval	Up Counting	Up/Down Counting	Microprocessor Interface	Hardwired Interface	PRICE (100's)
ICM7208	X	2	7	X					X			X			X	$10.59 (ICM7208IPI)
ICM7216	X	10	8	X			X	X	X	X	X	X			X	13.35 (ICM7216DIPI)
ICM7217	X	5	4	X					X				X	X	X	6.10 (ICM7217CIPI)
ICM7224	X	25	4½		X				X			X			X	7.00 (ICM7224IPL)
ICM7225	X	25	4½	X					X			X			X	5.30 (ICM7225IPL)
ICM7226	X	10	8	X			X	X	X	X	X	X		X	X	16.65 (ICM7226BIPL)
ICM7227	X	5	4	X					X				X	X		7.30 (ICM7227AIPI)
ICM7236	X	25	4½			X			X			X			X	4.25 (ICM7236IPL)

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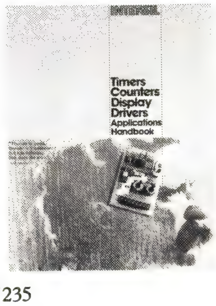

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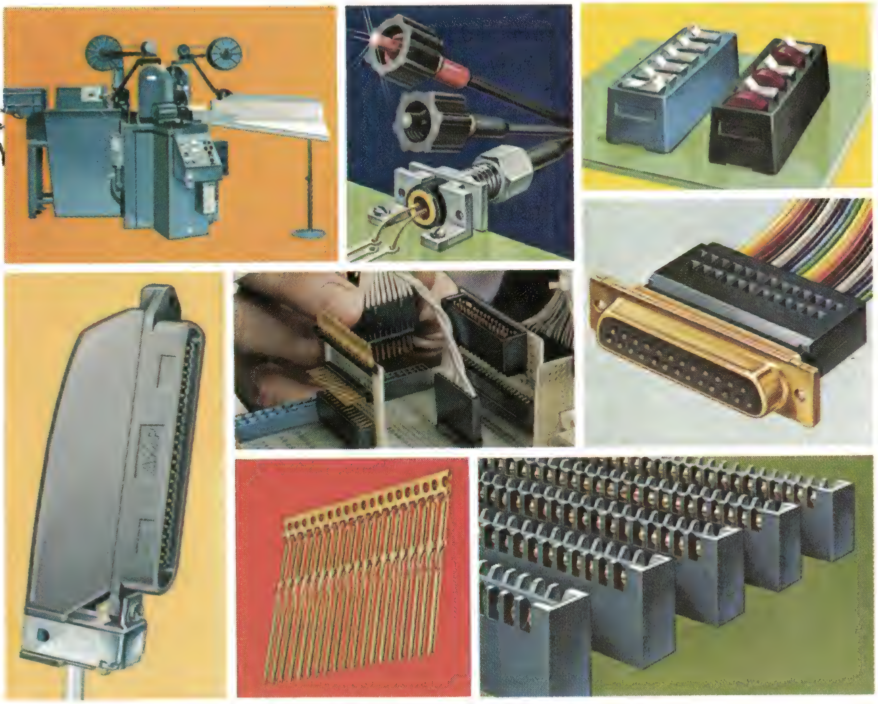

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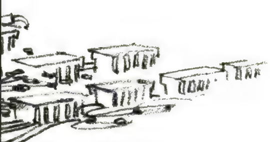
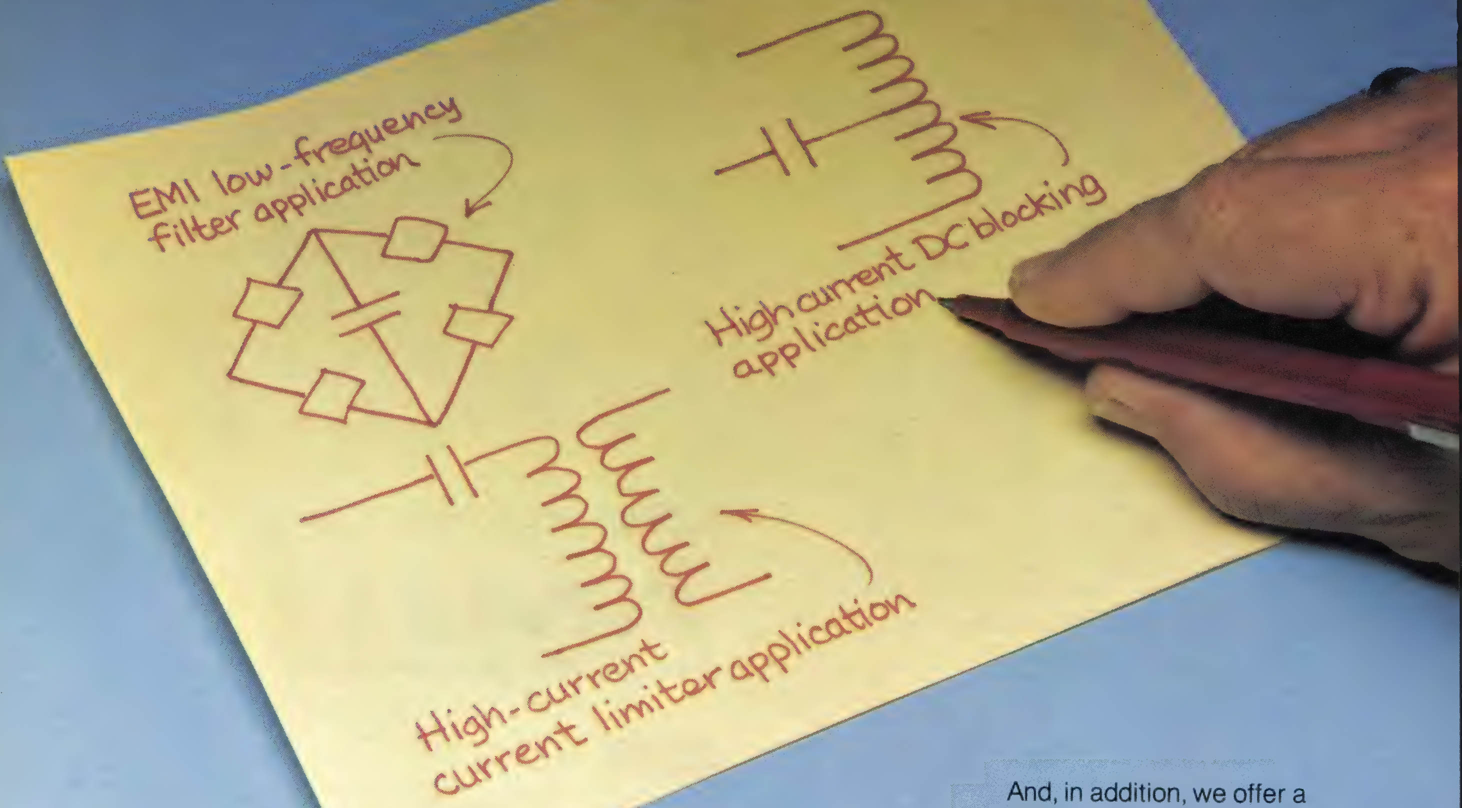


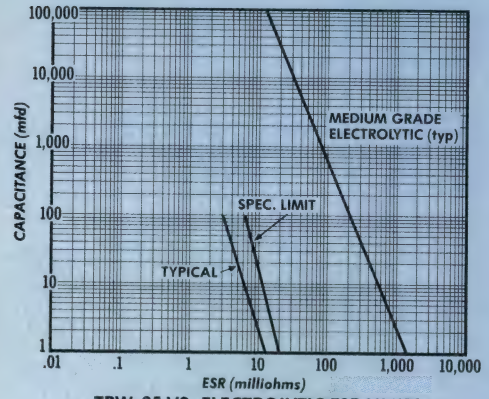
CIRCLE NUMBER 40

Why the switch is on to film capacitor filters.

(30-80% higher SPS efficiency.)


EMI low-frequency filter application
High current DC blocking application
High-current current limiter application

For switching power supplies the evidence is conclusive. Where a filter capacitance of 50 mfd or less will do, metallized polypropylene (film) capacitors far surpass electrolytics in impedance characteristics.



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CIRCLE NUMBER 41

System capabilities get a boost from a high-powered dedicated slave

For the NS16000 family of 16-bit microprocessors, slave processors, like the NS16081 floating-point slave, handle functions that cannot be fabricated economically right on the chip with the CPU.

The NS16081 performs a 32-bit floating point multiply or divide in well under 10 μs, and double-precision in less than double the time. Its dedicated architecture draws upon CPU functions (such as memory cycle or effective-address generation), so the chip is smaller than an equivalent chip that uses a general-purpose architecture. Able to operate in either its slave mode or in a system mode, the NS16081 can enhance the performance of any system that needs floating-point capability. (See "Why Floating Point," p. 81.) In the peripheral mode, the circuit can adapt to any bus-oriented μP with a minimum of interface logic. And as a slave, the NS16081 prevents circuit designs from being compromised by an attempt to squeeze all functions onto a single chip.

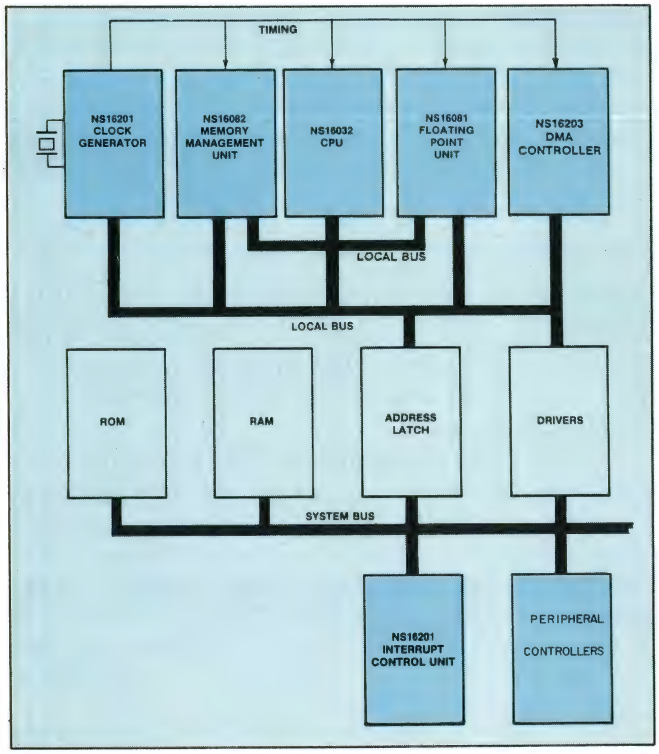
Easing the transition from 8 to 16 and eventually 32-bit processors, the architecture of the NS16000 family expands easily, is optimized for high-level languages, and takes full advantage of slave processors. (For an overview of the NS16000 family, see "Bilingual 16-bit μP Summons Large-scale Computer Power," ELECTRONIC DESIGN, Jan. 18, 1980, p. 66.)

The hardware protocol between the master CPU and the 16081 (or other slaves) is self-contained. The slave processor never controls the main system bus, but reacts on a separate local bus with the host CPU (Fig. 1). Even though the slave processor is external to the host CPU, all of the CPU's registers and facilities can be considered an integral part of the system.

The slave also takes advantage of the CPU's addressing modes. These addressing modes are very handy for efficient handling of floating-point data. For example, the "scaled indexed" addressing mode permits an array of floating-point data elements to be addressed by its logical index, rather than its physical address (Fig. 2).

For example, assume the CPU register R_ϕ contains a logical index P for a 64-bit floating-point number in the array (however, any of the eight R registers will do). This element could be addressed by an index value P, automatically scaled by 8 and added to the base address to generate the physical address. Even though the slave performs the floating-point computations and the CPU performs the address calculations, the CPU address modes access the floating-point data structures.

Another benefit of the slave architecture is the lack of restrictions on the number of slaves that can be



1. Using the master/slave concept, complex systems can be designed around the NS16000 microprocessor family. Simple functional enhancement does not cause a loss of software since the hardware is transparent to the user—the support functions may all be placed on one chip or they may be split between several chips.

Subash Bal, Product Manager (NS16000), **Ed Burdick,** Member Technical Staff, **Rick Barth,** Design Engineer, and **Dan Bodine,** Design Engineer, National Semiconductor, 2900 Semiconductor Dr., Santa Clara, CA 95050.

used in a system, as long as only one slave of each kind is on the bus. Thus, four or five slave processors, each with a different instruction set, could work alongside the CPU on the same bus.

Use of the slave processors is transparent to the software. As an example, imagine a CPU that has a basic instruction set "X" and an application that requires an additional instruction set, "Y" (that performs, say, floating-point math operations). Even though the Y instructions will be executed by a slave processor, the software instruction flow of the CPU must contain instructions X plus instructions Y in the desired sequence, as if both sets of instructions were built into the CPU.

The software, written in this form is "transparent" to the hardware organization of both the host and slave processors. During program execution, the CPU executes the main flow of "X" instructions until it encounters a Y instruction. The CPU then directs the slave processor to execute that operation. After the instruction has been executed, the CPU regains control and executes the next instruction, which could be either another Y operation or an X instruction.

Communication and data transfer between the host CPU and the slave involves:

- Data lines that are part of the microprocessor system bus (Fig. 3a)
- A bidirectional Slave Processor Control (NSPC) line
- Two control lines on the CPU that mate with two control lines on the slave processor (Fig. 3b)
- A simple protocol.

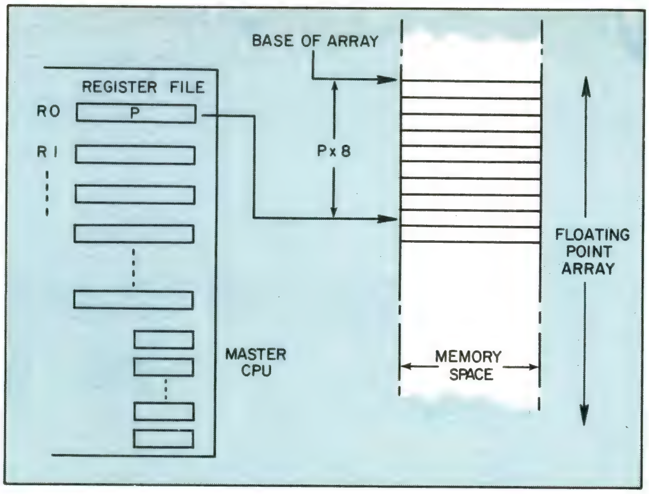
Narrow the communication gap

The major control line between the master and slave is the Slave Processor Control (NSPC) signal. This bidirectional signal can be pulled low by both the master and the slave during the interprocessor communication sequence.

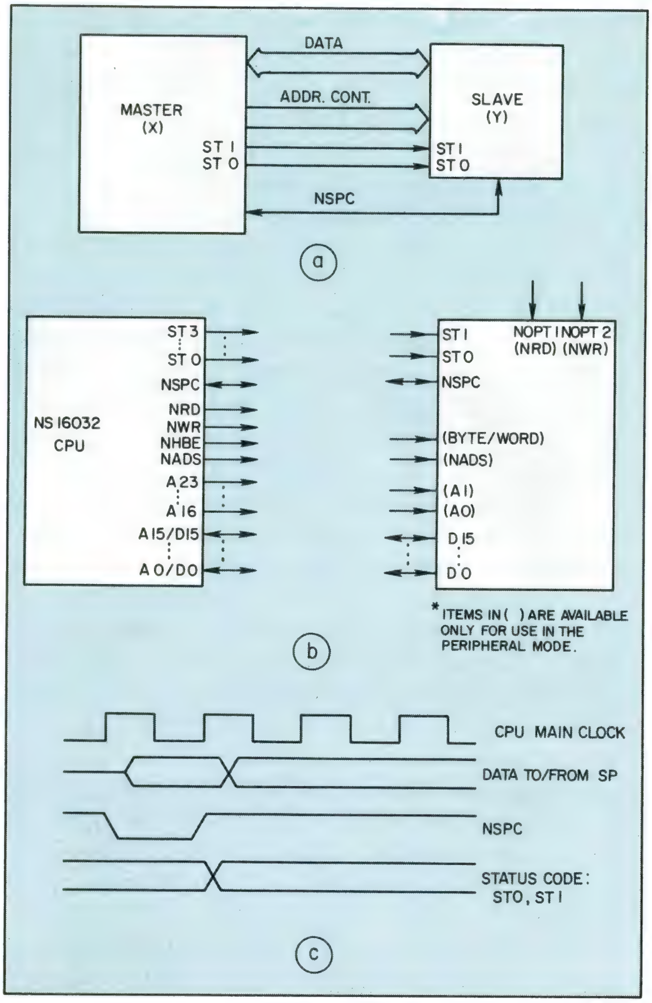
Four CPU status output lines, ST_0 to ST_3, provide a 4-bit encoded output to indicate the internal status of the CPU during various operations. The slave processor has two status inputs that decode two of the CPU status lines to determine what part of the operation must be performed.

When the master CPU detects an instruction that the slave must execute, the CPU asserts the NSPC signal and the appropriate status code. This communicates to all the slaves that an ID code for a particular slave is being transmitted on the data lines (Fig. 3c). The slave with the matching ID then gets ready to receive further information. Once the slave recognizes its ID code, and is enabled, operation (op) codes and operands are transferred on the data lines to the slave. Each cycle, the proper status code (Send OP Code/Operand) and the NSPC line are activated.

The op code transferred will specify the instruction to be executed and which of the slave registers is to help in its execution. The master CPU uses the



2. The scaled indexing address mode of the NS16000 family of processors permits an array of floating-point elements to be addressed by its logical index rather than its physical address.



3. The interconnect between the master CPU and a slave processor takes place on a local bus (a) and requires just three basic control signals—the ST_0 and ST_1 lines and the NSPC control (b). Control timing starts when the master CPU detects a slave instruction; it then asserts the NSPC signal and sends the appropriate ID code (c).

necessary address modes (that are part of the instruction) to fetch the actual data from memory.

Once the slave starts executing its routine, the CPU waits for it to finish. However, while it is waiting, the CPU can perform memory cycles, grant access to the bus or do some preprocessing on the instructions following the slave instruction.

After the slave has finished, it signals the master CPU by pulsing the NSPC line low. The CPU then reads the status word from the slave. The least significant byte of that word is a trap control byte—if it is set, the CPU will perform a Trap operation. If the results are to be sent to the CPU or memory, the CPU will perform additional read cycles from the slave, with its status inputs indicating "Read SP Operand."

Using the NS16081 as a peripheral

The slave processor has two more control lines—the NOPT_1 and NOPT_2 input lines. These pins are strapped to ground for slave operation and serve as read and write control lines for the NS16081 as a peripheral.

When the slave operates in its peripheral mode, additional control comes from the CPU's NRD, NWR and NSPC signals. The NRD output line indicates when the CPU reads data into its registers. Under the NWR output, data are written into the external location addressed by the CPU.

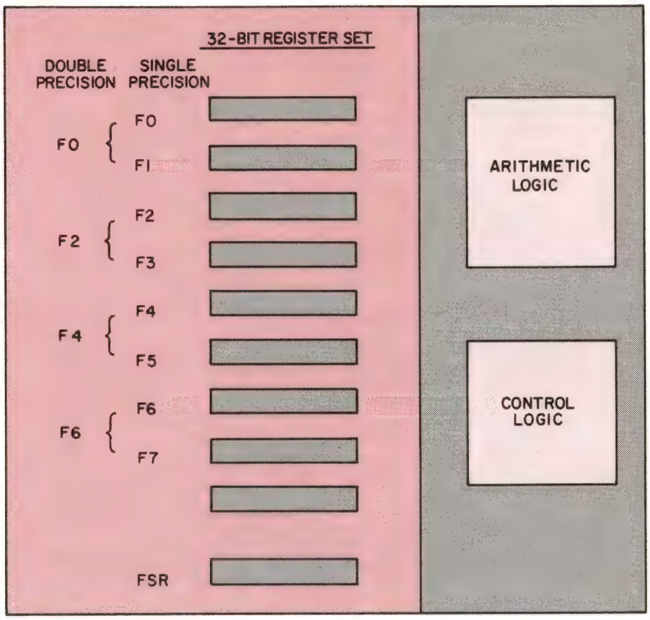
Aside from its address and data lines, the CPU has two more controls—the NADS and NHBE outputs. At the beginning of any memory cycle, the CPU's AD_0 to AD_{15} multiplexed address and data lines send out the lower 16 bits of a 24-bit address, which is held in an external latch by the NADS signal. Once the address is latched, the same pins become the bidirectional data lines on the next part of the cycle. The NHBE line, when low, enables the access of the high byte of the 16-bit multiplexed bus.

The 16081 is compatible with the proposed IEEE floating-point standard in floating-point format, reserved operands and rounding. It supports 32-bit and 64-bit precision floating-point and 8, 16 and 32-bit fixed-point calculations. When the 16081 is used as a slave processor, the programmer sees a set of eight 32-bit floating point registers; a set of floating point instructions that have the same formats as its fixed-point arithmetic and logic instructions; and a 32-bit status register (Fig. 4). Unlike the architecture of other microprocessors which support floating point, the architecture of the NS16000 makes available to the slave all the NS16000 addressing modes, and any instructions can be register-to-register, register-to-memory, memory-to-register or memory-to-memory.

The floating-point registers can each store a single-precision operand or half of a double-precision operand. The instructions in the slave processors instruction set (see table) are mostly two-operand instructions (as are most of the NS16000 instructions). Source and destination are lengths specified together, either as single precision or as double precision. However, some instructions (such as the DOT product and POLYNOMIAL) use three operands. In these cases, the source and destination can be single or double precision, either together or separately. When a double-precision instruction, using registers, is executed, the register number must be even (0, 2, 4 or 6). The integer format conversion instructions operate on byte,

Capabilities of the NS16081

Arithmetic (single and double precision)
ADD
SUBTRACT
MULTIPLY
DIVIDE
Conversion
FIXED TO FLOATING POINT
(single and double precision)
FLOATING POINT TO FIXED
(single and double precision)
ROUNDING
TRUNCATE
Transcendental Function Support
POLYNOMIAL STEP
Matrix Multiplication
DOT PRODUCT STEP
Miscellaneous
COMPARE
MOVE, etc.



4. The basic programmer's model of the NS16081 floating-point slave processor consists of eight 32-bit general-purpose registers and one 32-bit status register that interface to the arithmetic and control logic sections.

double-byte and quad-byte two's complement integers.

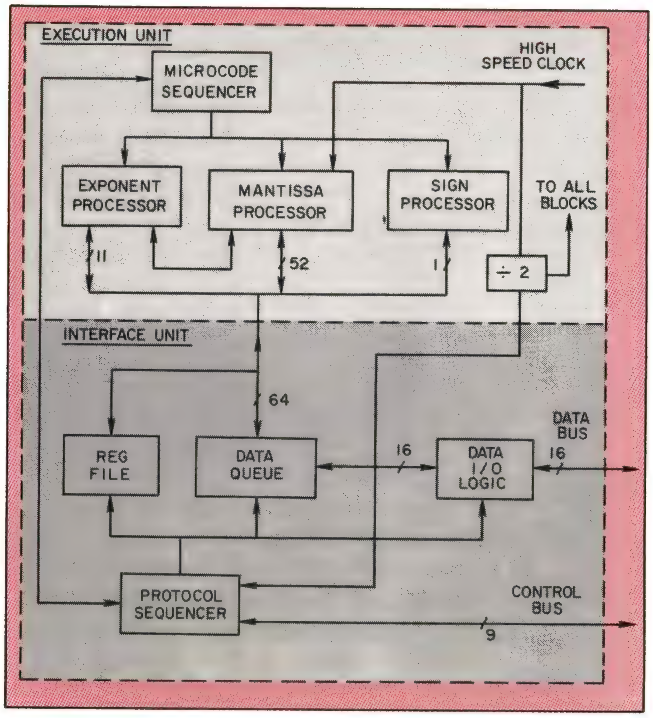
As part of the register set, the floating-point status register (FSR) holds mode-control information, error bits and trap enables. Like the other registers, the FSR is 32-bits wide.

Traps are provided for overflow, underflow, divide by zero, reserved operand, invalid operations, illegal instructions and inexact results. Sticky flags are provided for overflow, underflow, illegal division, inexact result and invalid operation. All traps can be individually enabled or disabled by the programmer.

Error handling in the 16081 is compatible with the 16000-family trap structure—when an error is detected, the 16081 checks its FSR to see if the corresponding trap is enabled. If it is, no result is returned; instead, the 16081 causes the CPU to access a table in the main memory that tells it where to jump for the trap, and the trap software does the necessary recovery. If the trap is not enabled, a default value is returned and a sticky flag is set in the FSR, indicating that an error has occurred. The error flags can be checked at any time, and can only be cleared by specifically modifying the register.

Looking inside

Internally, the 16081 has two main subsections, an interface unit and an execution unit (Fig. 5). The interface unit contains the register file, the data queue, the I/O logic and the protocol sequencer. The sequencer controls all data transfers between the I/O lines and the queue. The queue buffers all memory source and destination operands, and aligns them, if necessary, with the 64-bit execution unit and register file buses. The register file stores all register operands. The I/O logic pipelines data between the 16-bit external data bus and the data queue.



5. The arithmetic and control logic sections of the floating-point processor are split into an execution unit section and an interface unit section. The execution unit handles the basic calculations for the mantissa, sign and exponent; the interface unit controls the data queue and I/O operations.

The execution unit consists of the mantissa processor, the exponent processor, the sign processor and a microcode sequencer. The exponent processor is controlled by the sequencer and executes all exponent operations and tests. Similarly, the sign processor executes all sign calculations and tests. The mantissa processor is controlled by the microcode sequencer only in data moves between its internal units. All looping operations (multiply, divide, normalize and add/subtract prealignment) are controlled by high-speed local logic. All mantissa and control operations are carried out in parallel, and, combined with the advanced design of the arithmetic logic, endow the 16081 with its excellent performance.

Between the exponent processor and the mantissa processor is a 6-bit-wide bit-count bus. This bus communicates shift displacements and other position-oriented data between the two subsections. For example, it tells the exponent processor how many positions the mantissa was shifted after a normalize operation. Although the 16081's microcode and logic have been optimized for single-precision operations, the mantissa processor performs double-precision operations in a single pass. Typical register-to-register double-precision instructions require just 50% more time than the corresponding single-precision operations. Thus, any of the instructions executed in the 16081, including double-precision multiply or divide, take well under 20 μs to execute.

How it works

As an example of how the CPU and slave operate, examine the program flow when the CPU evaluates the expression

$$A = (C + B\,[I, J, K]) \times 4.5,$$

where A and C are real floating-point numbers; I, J and K are integer numbers with values from 0 to 5; and B is an array [0. . .5, 0. . .5, 0. . .5] of real numbers. A and C will be stored in registers f_0 and f_1 of the floating-point slave, while I is stored in register r_0, J is held in r_1, and K is held in r_2, of the master CPU (a 16032 in this case). The instruction sequence could then become:

```
movf     f1, f0 ; register f0 ← contents of f1
movd     r0, r3 ; register r3 ← contents of r0
Indexb   r3, #5, r1 ; index calculation, r3 ← r3 × 5 +
         r3 + r1
Indexb   r3, #5, r2 ; index calculation, r3 ← r3 × 5 +
         r3 + r2
Addf     B [r3 : f], f0 ; f0 ← B [I, J, K] + f0
mulf     #4.5, f0 ; f0 ← 4.5 × f0
```

This entire sequence requires about 25 bytes. In the

Why floating-point?

In a computer, numbers are usually represented as simply as possible—integer or fixed-point numbers are represented in two's complement format, where every bit has a fixed weight and the resolution is uniform throughout the entire range. These numbers add and subtract quickly.

To represent integers, numbers can be scaled by using negative or positive powers of two (below). For a wider

Bit Weights				
2^{-1}	2^{-2}	2^{-3}	2^{-4}	Value
1	1	1	1	15/16
1	1	1	0	7/8
1	1	0	1	13/16
1	1	0	0	3/4
1	0	1	1	11/16
1	0	1	0	5/8
1	0	0	1	9/16
1	0	0	0	1/2
0	1	1	1	7/16
0	1	1	0	3/8
0	1	0	1	5/16
0	1	0	0	1/4
0	0	1	1	3/16
0	0	1	0	1/8
0	0	0	1	1/16
0	0	0	0	0

range, say from 1/16 to seven or eight, more bits may be used to create four bit positions to the left of the binary point and four bit positions to the right.

With more bits, the range increases considerably. For example, 16 bits can represent all numbers from −32,768 to +32,767 in steps of one, or the numbers −1 to +1 in steps of 1/128 (0.0078). And 32 can represent -2×10^9 to 2×10^9 in steps of one, or −1 to +1 in steps of 5×10^{-10}. The problem, though, is that even with 32 bits, the maximum range is about 10^{10}. Thus, to handle numbers like the rest mass of an electron (9.1085×10^{-3} kg) or Avogadro's number (6×10^{23} molecules/mole), the fixed-point approach is inadequate. The 9.1085 would alone require 17 bits and a range of 10^{54} would be required to represent both constants —a total of 182 bits.

Fortunately, large range and fine resolution are not normally required simultaneously. The 200 or so bits required by the terms mentioned earlier would contain mostly leading and trailing zeros in most cases. Those zeros would be wasted bits. The floating-point binary notation was developed to eliminate wasted bits.

To represent a floating-point number, the binary number is divided into three sections: a sign field, an exponent field and a fraction field. The fraction field contains a precise number with a very small range (1 to 2 in 16081 format). The exponent field specifies what the fraction should be multiplied by, to yield the floating-point number. In the 16081, the exponent is 8 or 11 bits, and the fraction is 23 bits for short precision or 52 bits for long precision. The most significant bit specifies the sign (below).

	S	EXP	FRAC
SHORT	**S**	**EXP**	**FRAC**
Number of bits	**1**	**8**	**23**
LONG	**S**	**EXP**	**FRAC**
Number of bits	**1**	**11**	**52**

NUMBER = $(-1)^s \times 2\ (\mathrm{EXP}-\mathrm{BIAS}) \times (1 + \mathrm{FRAC})$, where BIAS = 127 for short and 1023 for long.

In addition to the use of the floating-point format, special operands must be encoded in the 16081 to represent quantities that are discontinuous from the floating-point numbers (below). Two of the values in the exponent field are reserved, and the interpretation of the number is changed whenever either of these values appears.

	S	EXP	FRAC
+0	0	0—0	0-------------------0
−0	1	0—0	0-------------------0
+∞	0	1—1	0-------------------0
−∞	1	1—1	0-------------------0
NANS:			
TRAPPING	X	1—1	1X-----------------X
NONTRAPPING	X	1—1	0X-----------------X
INDETERMINANT RESULT	0	1—1	010----------------0
RESERVED OPERAND	0	0—0	X-------------------X
			NON-ZERO

For example, if EXP and FRAC are both entirely zeros, the number is defined to be the additive identity, ±0. If EXP is zero and FRAC is nonzero, the number is an undefined reserved operand. Upon encountering such an operand, the 16081 performs a trap operation, which allows software to use the contents of this operand as the user desires. The 16081 never generates this kind of reserved operand; therefore, the software can use them for gradual underflow schemes or pointers.

If EXP is all ones and FRAC is all zeros, the number is defined to be ±infinity. If EXP is all ones and FRAC is not .010—0, then the number is defined as an indeterminate result. These responses can be generated by the 16081 if errors occur when error traps are disabled. If the first bit of a NAN is a one, the 16081 will always trap upon encountering it. However, if the first bit of a NAN is a zero, the 16081 will not trap, but will pass the NAN unchanged to the result. If two such NANs are encountered, the one with the larger absolute value will be passed to the result; an indeterminate result is the only NAN ever generated by the 16081.

All floating-point numbers manipulated by the 16081 are normalized numbers. The fraction field of a normalized number is always less than two and greater than or equal to one. The bit with weight 2^0 (most significant bit) is therefore always a one. This bit is not stored in the memory of any other storage device since it can always be assumed to be a one. It is called the hidden bit; inside the 16081 arithmetic unit, the hidden bit is embodied in hardware because it can be cleared by internal operations. The example shown below shows how this bit can be affected.

$$\begin{array}{rr} 1.1101000\times2^{3} & (14.5) \\ -1.1100000\times2^{3} & (14.0) \\ \hline 0.0001000\times2^{3} & (0.5) \\ 2^{-1}2^{-2}2^{-3}2^{-4} & \end{array}$$

Normalization by multiplying result by 2^{-4} to get 1.0000000×2^{-1}

The difference of the subtraction example is not normalized (the fraction field is 1/16, which is less than one). However, the 16081 will normalize the result by shifting the binary point four places to the right and subtracting four from the exponent value. The fraction result is now greater than or equal to one and less than two.

sequence of CPU fetches, the slave will execute the first, fifth and sixth instructions. While the slave performs the operation, the CPU can proceed to normal operations, such as prefetches of the following instructions, but will not execute any instructions.

Using the 16081 as a peripheral

In addition to operating as a slave processor, the 16081 can be used as a peripheral support circuit in bus-organized microprocessor-based systems—such as an 8080, 8085 or NSC800 system. In this mode, the programmer takes responsibility for loading the instruction and operands into the 16081 floating-point processor and for retrieving the results. Since these operations are performed by macroinstructions rather than by microcode, they will be performed more slowly than when the 16081 acts as a slave. Also, some of the internal architecture of the 16081 will become visible to the programmer, since the programmer must take over the function of the CPU microcode. The queue register, instruction register and FSR are directly addressable by the programmer. To execute an instruction, the programmer must store it in the instruction register, store any required operands in the queue and then start the unit by manipulating a bit in the FSR. After the instruction completes, results must then be read out of the queue.

One pin on the 16081 indicates whether the circuit is busy. This pin can be used the generate wait states, or it can provide an interrupt or a level for software to test whether an instruction is finished. Most microprocessors can only execute a few instructions while the 16081 is executing an operation, so generating wait states will probably make the most sense. The 16081 will operate with either 8 or 16-bit bus systems selected by strapping one control pin.

Along with the NS16081, National is initially planning to introduce another slave processor, the NS16082, a memory management unit. Its principal function is memory protection and dynamic address translation (from virtual to physical addresses). This virtual memory management is a first for microprocessors; it has traditionally been associated with large main-frame computer systems and high-end minis. The slave MMU will also provide high-level software debug facilities during program generation.

While the floating-point processor is an extension of the NS16000 family instruction set, the MMU provides an extension of system-oriented capabilities. However, as semiconductor processing techniques improve, the 16032 CPU, the 16081 and 16082 could potentially be integrated on to a single chip, without any software changes by the user. ■■

How useful?	**Circle No.**
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Within the next year	**548**
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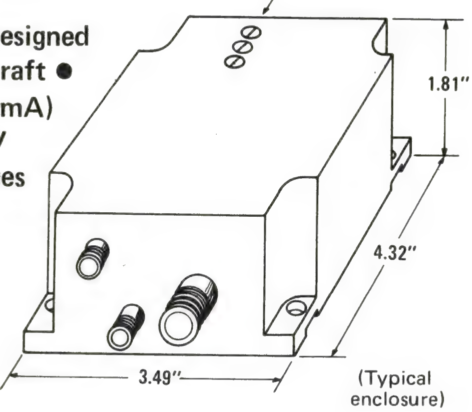

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CIRCLE NUMBER 45

Capacitors and inductors lead the way to compact, high-frequency switchers

This article, the third in a series on high-frequency switching power-supply design, covers the developments associated not only with traditional passive components (capacitors and magnetics) but also with a relative newcomer to switchers, the pulse-width-modulator IC. The concluding article will present several high-frequency circuits that apply the design principles examined in the previous articles.

So far, component and design problems besetting high-frequency (200-kHz and above) switch-mode converters tend to make them more expensive than their low-frequency counterparts. However, there are components and materials available now to form the basis of high-frequency power converters that are smaller and more efficient. More than any other switcher components, the capacitor and transformer materials permissible at high frequencies should help bring about the reductions in power-supply weight and volume that accompany operating at or above 200 kHz (for more size considerations, see "More than Frequency").

Seemingly, small, high-frequency switchers should be less expensive than large, low-frequency units (see table entitled "High-frequency Cost Tradeoffs"). At this point, however, problems such as difficult transformer design, inadequate availability of suitable pulse-width-modulated ICs and increased attention to circuit layout tend to make them more expensive. Fortunately, there are certain types of capacitors and transformers to point high-frequency designs in the right direction.

Capacitors—ESR is the key

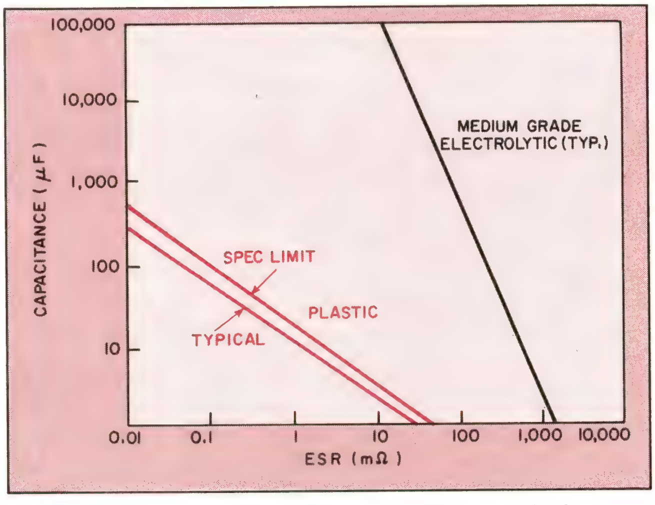
At high frequency, small ceramic or plastic-film capacitors provide low equivalent series resistance (ESR)—up to two orders of magnitude lower than the best electrolytic capacitor (Fig. 1).

At low frequency (20 kHz), electrolytic-capacitor size is determined by the ESR required by the circuit's ripple current. Most often, the value of capacitance selected must be greater than needed to get low ESR. Obviously, the result is a large capacitor.

In addition, the parasitic inductance and resistance of the capacitor form a low-Q, self-resonant circuit. At frequencies below self-resonance, the capacitor acts as a capacitive impedance, but above self-resonance, it is inductive. Electrolytics with large capacitance values have very low self-resonant frequencies. Also, since an electrolytic's ESR does not change much above 20 kHz, the capacitor's size, for a given ripple current, is essentially independent of frequency.

For the small ceramic and plastic capacitors, low ESR value is an asset because it raises the self-resonant frequency. On the other hand, increased current flow through the capacitor lowers the self-resonant frequency. If this occurs in high-power switchers, impedance can become excessive.

One way to reduce impedance is to parallel a few capacitors of high self-resonant frequency in a low-inductance structure. Another is to parallel a large and a small capacitor as shown in Fig. 2a to produce the impedance characteristic in Fig. 2b. It is important to realize that a capacitor's effective equivalent series inductance (ESL) includes its leads and the way in which it is mounted. Thus, a capacitor that mounts



1. Plastic-film capacitors offer much lower equivalent-series-resistance (ESR) values than electrolytic capacitors. The low ESR of film devices helps high-frequency operation by increasing the capacitor's self-resonant frequency.

Rudolf Severns, Power MOSFET Applications Manager, Intersil, Inc., 10710 N. Tantau Ave., Cupertino, CA 95014.

standing up on a nonground-plane PC board can have a lower resonant frequency than the same device mounted close to a ground plane with minimum lead length, and with its outer foil connected to the ground plane.

Although ceramic capacitors are the most suitable and effective choice when the application calls for small capacitance values, be careful when selecting them—not all ceramic dielectrics are low-loss types. While careful capacitor selection yields space and cost-saving benefits, the most critical choices for any high-frequency switcher lie in the methods of handling its magnetics.

Selecting transformer materials

As it happens, the power transformer is usually the most difficult component to design in a high-frequency switcher. If the transformer's flux density is restricted to reduce self-heating, most of the common core materials—ferrite, powdered-iron, tape-core and amorphous—are suitable at 200 kHz.

For a transformer core, the first choice is a ferrite such as Ferroxcube 3C8 or Mag-Inc.'s F material. But if either mechanical or temperature conditions eliminate ferrites, a thin (< ½ mil) tape core can be used—provided the flux density is kept low.

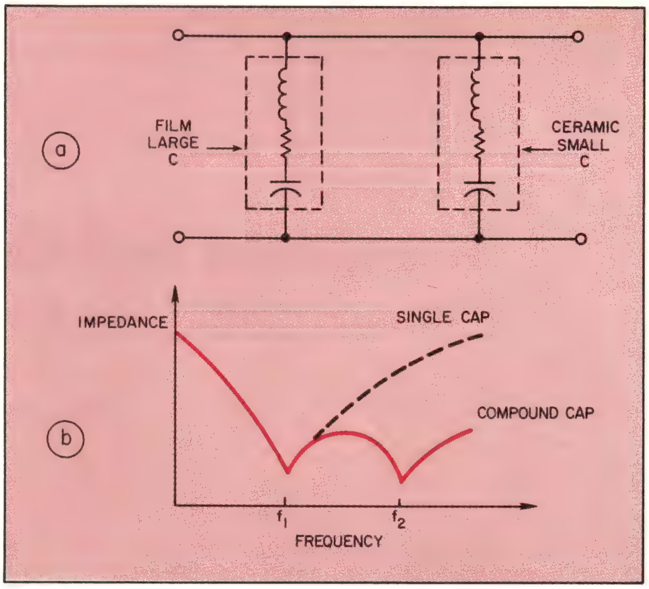
For high-frequency chokes, the choice is powdered-iron toroids. This is not true at 20 kHz, where the low-μ powdered iron is a disadvantage, and molypermalloy is preferred. At 200 kHz, powdered iron not only works better, it also costs about 90% less than molypermalloy.

At high frequency, one particular core shape—cup core, E/I, toroid, among others—is as good as another. In fact, because of the reduced number of turns, most cores have too much window for the core area, so the proportions of standard shapes are not optimum. When problems occur, custom cores can be an expensive solution; but as designers increasingly opt for higher frequencies, manufacturers will be forced to develop standard sizes for this application.

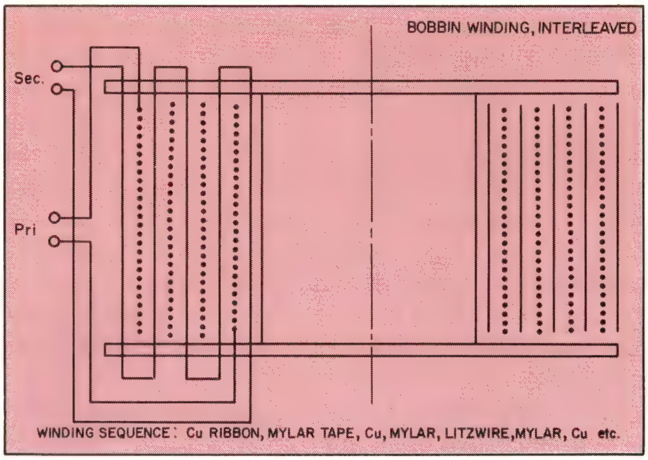
While high-frequency magnetic devices can be wound with standard magnet wire, better copper utilization is gained with either Litz wire, multifilar-magnet wire or copper ribbon. These materials reduce skin effects, which increase above 100 kHz, and even at lower frequencies if the power is high.

The principle behind both Litz and multifilar-magnet wire is that the smaller the wire gauge, the better the copper utilization. Many small, parallel wires offer lower ac resistance than the same amount of copper in a single wire. Litz and multifilar wire are essentially the same except that Litz is braided, to further balance current distribution, and costs more. However, this is offset by the very small amounts typically required. There is one problem with Litz wire: stripping the many wires to make connections.

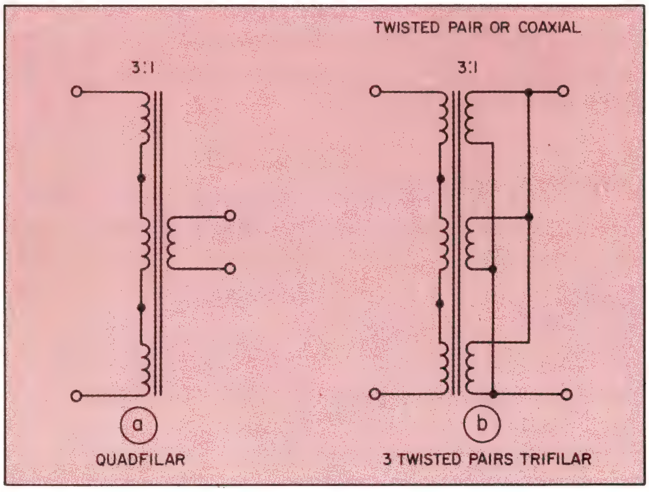
But an even bigger challenge lies in winding the power transformer not only to reduce the leakage



2. Paralleling two capacitors produces a compound capacitor (a) whose equivalent impedance goes down while self-resonant frequency (b) goes up. Although there are limits to paralleling, it's important in high-frequency switchers that also handle high current.


BOBBIN WINDING, INTERLEAVED
Sec.
Pri
WINDING SEQUENCE: Cu RIBBON, MYLAR TAPE, Cu, MYLAR, LITZWIRE, MYLAR, Cu etc.

3. High-frequency switcher performance hinges on proper transformer winding. Interleaving is one way to go in less critical applications.



4. For the most critical switchers, transformers are wound with twisted-pair or coaxial transmission lines.

inductance but also to produce symmetrical and predictable voltages in the output winding.

Winding transformers—the true test

First, layers of the primary and secondary can be interleaved (Fig. 3). Even better coupling results when the primary and secondary are wound in a multifilar fashion in each layer. Perhaps the best coupling comes when the primary and secondary windings consist of twisted or coaxial transmission lines (Fig. 4). This is the principle of so-called rf transmission-line transformers (see Fig. 5a, b and c). A 1-kW, 200-kHz version of the transformer in Fig. 5c has been built with a turns ratio of 31:1—the leakage inductance seen from the 31-turn primary is just 1.9 μH.

In a true rf transmission-line transformer, both source and load impedances are directly related to the winding's characteristic impedance. While this permits an extremely wide bandwidth, such impedance matching is not very practical for switching regulators. Nevertheless, even mismatched coaxial transformers are wideband. One way to make improvements is to reduce the turns ratio in the isolation transformer by cascading an rf transformer with a conventional transformer. This way, the major benefit of rf transformers is retained—simple and inexpensive structures.

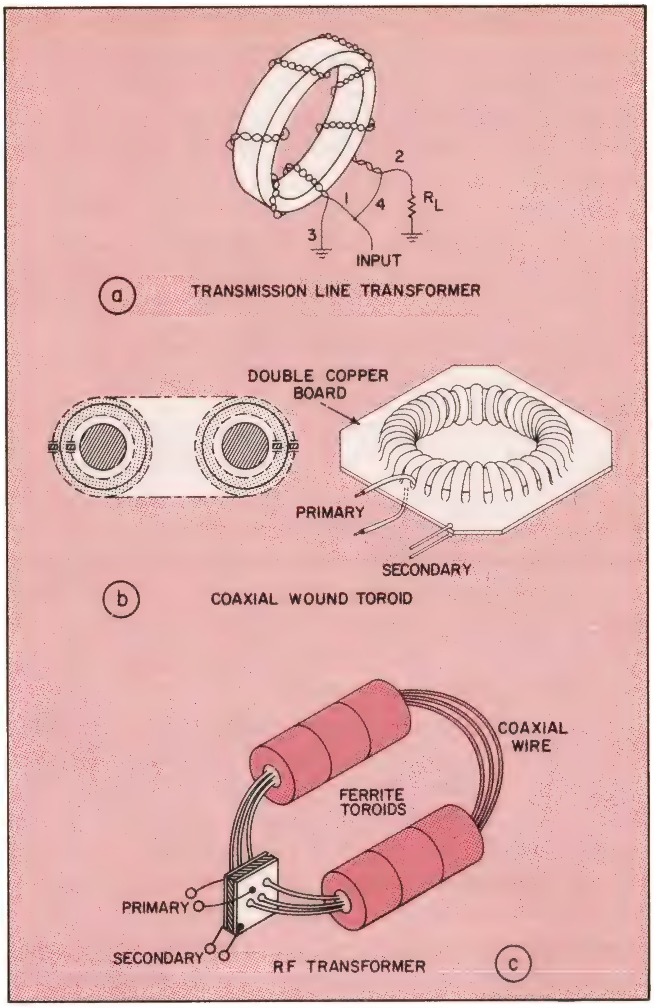
Inductors display parallel self-resonance because of their winding capacity. To obtain adequate filtering, the self-resonant frequency must be kept well above the ripple frequency. High self-resonant frequency is attained by reducing winding capacity with one of the following methods: single layer with spaced turns; bank winding, maintaining a large gap between the ends of the winding; or minimizing winding-to-core capacity by wrapping the core with a low-K dielectric.

However, self-resonant frequency improvement cannot be pushed too far, and at some point, it becomes necessary to use a multisection filter like the one in Fig. 6. To avoid complicating the feedback-loop compensation, the additional poles should be above gain crossover and well damped. The requirement is met if ferrite beads are used for the high-frequency portion of the filter.

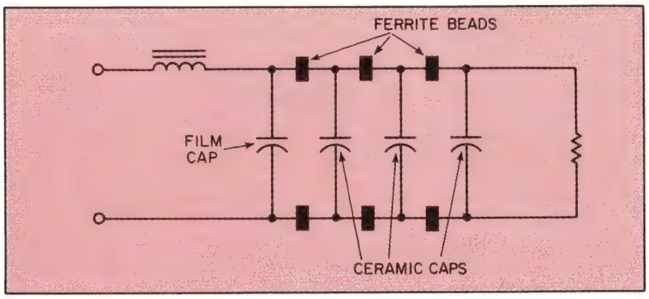
Capacitors and transformers, while a crucial part of the high-frequency design story, are by no means the only part. Switch-mode-converter design must deal with a new class of integrated circuits, which are on the verge of finding their way into the high-frequency domain: pulse-width modulators.

Few candidates

While a wide variety of IC op amps, comparators, pulse-width modulators and drivers are available to the 20-kHz switcher designer, the ranks thin out as the frequency goes up to 200 kHz. There are several limitations on the present crop of pulse-width-modulator ICs:



5. High-frequency transformers bear little resemblance to the devices found in 20-kHz switchers. All units shown here (a, b and c) are rf transmission-line transformers, specially constructed to deliver the best performance. The actual rf transformer (c) has been built to operate in a 200-kHz switch-mode converter.



6. A multisection filter becomes necessary at high frequency when it is no longer feasible to increase the inductor's self-resonant frequency. Ferrite beads form the high-frequency portion of the filter.

High-frequency cost tradeoffs

Advantages	Disadvantages
1. Less expensive magnetics	1. More expensive junction diodes
2. Less expensive EMI filters	2. More expensive bipolar switches
3. Less expensive filter capacitors	3. Shielding for RFI required
4. Power MOSFETs competitive in cost with low-frequency bipolars	

- Their operating frequency is limited. Maximum oscillator frequency for the majority of ICs is 100 kHz (a few run at 300 kHz, and one, the Ferranti ZN1066, operates at 500 kHz). Since a push-pull converter runs at half the oscillator frequency, all ICs used in switch-mode converters, except for the 500-kHz one, are limited to operating between 50 and 150 kHz.
- They lack source and sink output drivers—and source and sink capability is essential at high current levels. The feature helps provide proper drive for power MOSFETs and bipolar current.
- They cannot supply sufficient drive current. Current pulses of ±500 mA are required to quickly switch high-voltage power MOSFETs, a specification few ICs meet.
- Output transitions are too slow. Even in the Ferranti device, output-switch transitions as fast as 100 ns are too slow for 200-kHz transistor switches.
- Minimum dead time is excessive. A typical spec-sheet value for minimum dead time is 500 ns. At 200 kHz, this is 20% of a half-period, causing a serious reduction in dynamic range.

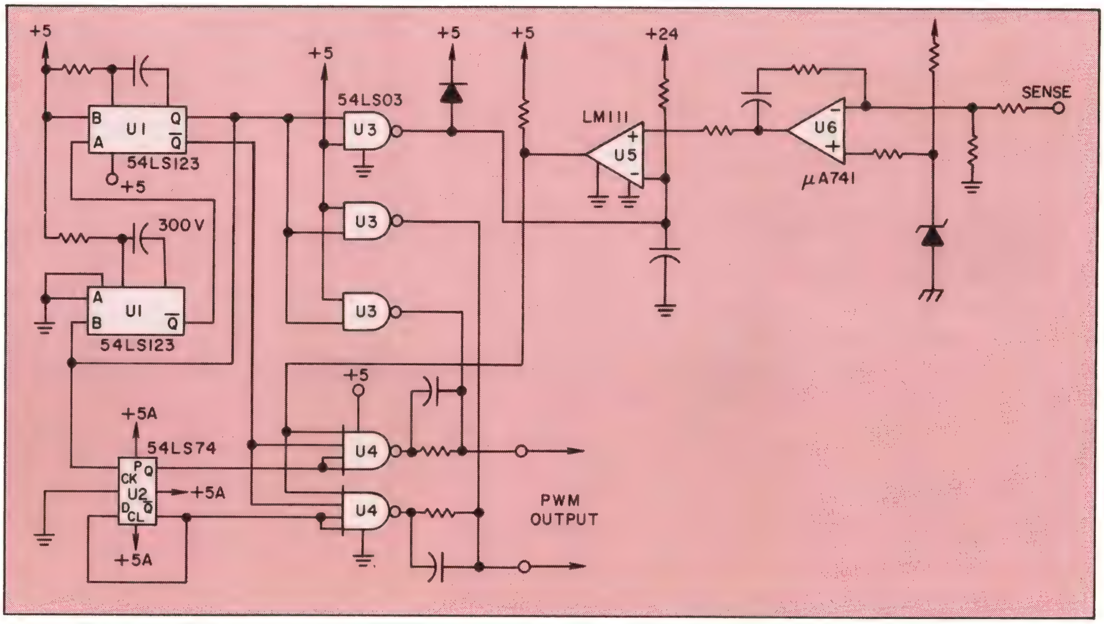
Given these limitations, designers may be forced to build their own modulators from logic ICs. One such circuit, a 300-kHz pulse-width modulator, is shown in Fig. 7. Two one-shots (U_1) connected as an asymmetrical oscillator produce a 100-ns pulse train for timing. The pulse-steering flip-flop is represented by U_2, while U_3 is an open collector gate for generating a ramp. The comparator is U_5, while U_6 is the error amplifier; U_4 and two gates of U_3 provide gating and inhibit functions. TTL 54/74LS-series logic is used to get adequate speed combined with reasonable power consumption.

Selecting suitable op amps for each design is not cut and dry, either. Currently available devices also have limitations:

- Bandwidth is limited. Many op amps, particularly the economical quad types, have open-loop bandwidths of 1 MHz or less. Operating the amp at a gain of 10 causes a pole to appear in the transfer function at 100 kHz or lower. If gain crossover is only 1 or 2 kHz, there is no problem; but 200-kHz switchers have gain crossovers at 20 or 50 kHz. At these high frequencies, compensation becomes difficult—and the amplifier's common-mode-noise rejection capability is greatly reduced.
- Subharmonic oscillations may occur. Amplifiers with high gain at high frequency show an increased tendency towards subharmonic oscillation. Oscillation, in the form of alternating pulses of different length, usually occurs at half the subharmonic frequency because of capacitive ripple-voltage feedback through the feedback amplifier. Because wideband op amps are mandatory, attack the problem in three ways: by shielding, by capacitor bypassing right at the op amp pins, and by paying careful attention to the board trace layouts to minimize capacitive pickup.
- Slew-rate limiting can be a problem. An op amp's power bandwidth or slew rate is critical at high frequency. The device must be able to drive compensation capacitors, in addition to any other load at its output.

Choices of IC comparators are also limited—in fact, with transitions required to be less than 100 ns, most ICs are eliminated. An exception is National's LM111, which is about as slow a device as can be used. An important point about comparators is that their switching speed is affected by the dv/dt of the input ramp. Therefore, use the maximum practical ramp amplitude to maximize the dv/dt.

For the best IC performance, use the best layout techniques. Indeed, apply the same principle to the entire high-frequency switcher. The methods that



7. Since few commercial pulse-width-modulator ICs will work in high-frequency switchers, one alternative is to build one with standard TTL logic. TTL 54/74LS-series logic offers a good compromise between speed and power consumption.

More than frequency

Increasing the frequency is not the only factor to be considered when contemplating size reductions of switching power supplies—power output is a factor that enters the picture.

For up to 10 W, high-frequency switchers stay about the same size as their lower-frequency counterparts. Between 10 and 100 W, volume can be reduced realistically by a factor of 1.5 to 2. Above 100 W, genuine improvement occurs—by a factor of three or more (see table entitled "High-frequency Size/Volume Tradeoffs").

The supply specification is just as important. For example, to accommodate a line-voltage dropout spec of 50 to 100 ms requires large energy-storage capacitors, which negates any size advantage operating at high frequency. But if dropout time is small, in a switcher that also takes advantage of conduction cooling, increasing the frequency would help reduce size dramatically.

High-frequency size/volume tradeoffs

Advantages	Disadvantages
1. Smaller transformers	1. Heat sinks no smaller
2. Much smaller RFI filters	2. Semiconductor packages no smaller
3. Smaller capacitors	3. Auxiliary circuits no smaller
	4. Line-holdup capacitors slightly smaller

work at 20 kHz don't stand a chance at 200 kHz.

With frequency components beyond 100 MHz, a 200-kHz switcher has more in common with a wideband rf amplifier than with a 20-kHz switcher. Therefore, the key to a successful layout is to think of the circuit as an rf amplifier.

While the final layout of a 200-kHz switcher will differ significantly from that of a 20-kHz supply, it need not be exotic or any more expensive. Because of the additional care required, it may even be less expensive. To assure proper performance, the following layout tips will help:

- Identify high di/dt paths to minimize their impedance.
- Minimize the area of current loops.
- Use twisted leads for transformer connections.
- Arrange transformer-lead breakouts to minimize interconnection inductance.
- Bypass high di/dt loops with ceramic capacitors.
- Use star or ring connections for parallel components—they work best.
- Use ground-plane construction. ▪▪

How useful?	Circle No.
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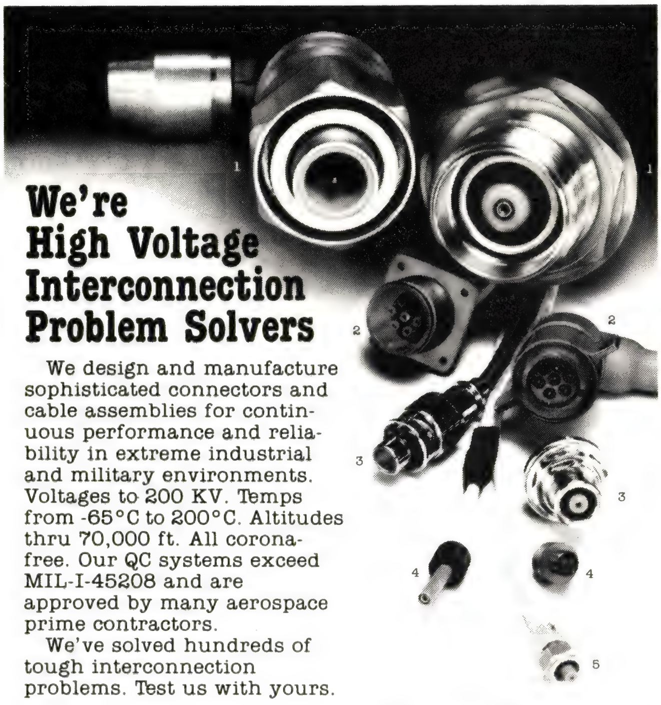

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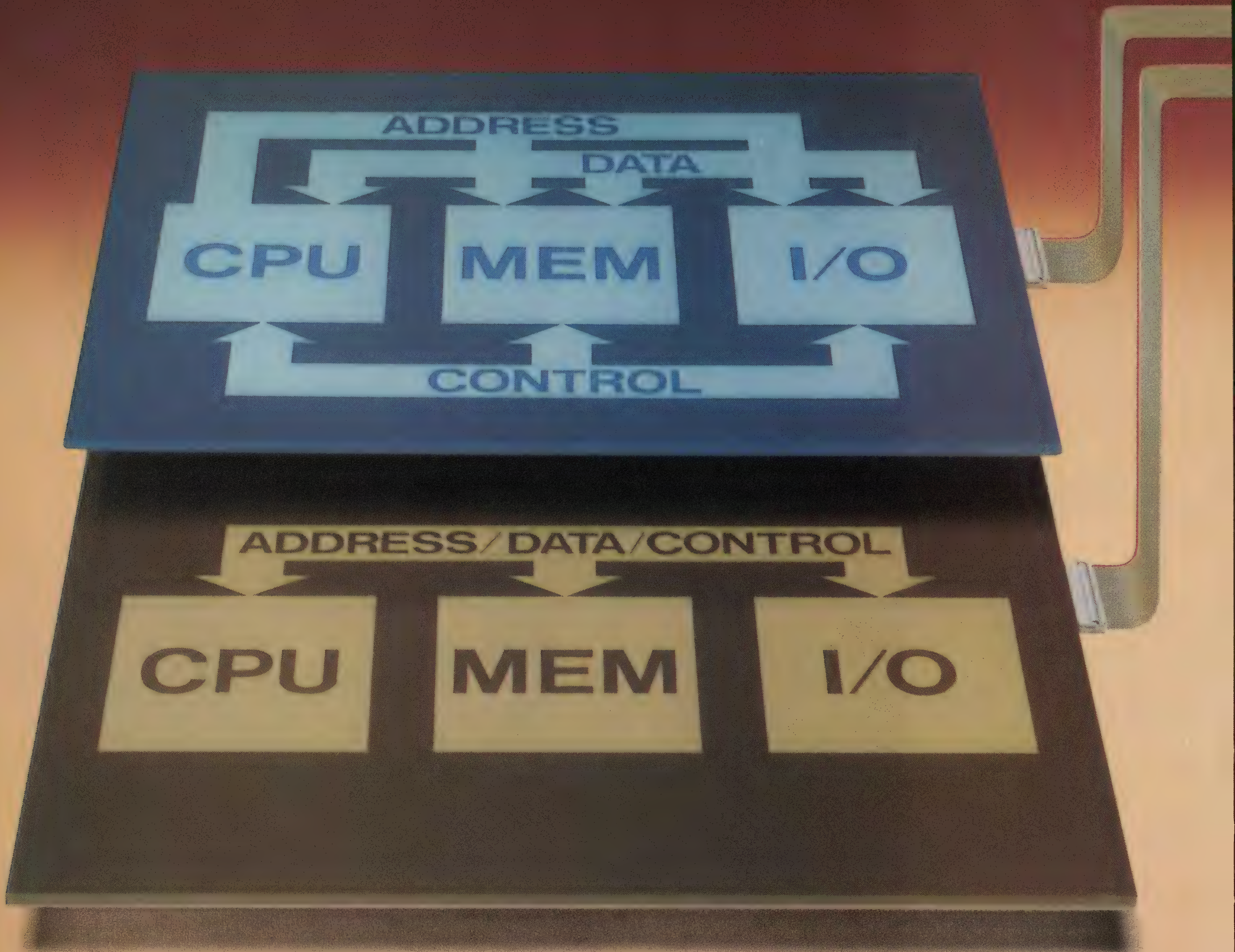

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But unlike other analyzers, the HP 1610B can also handle multiplexed-bus analysis just as effectively. The reason? Because with multiplexed buses, addresses and data appear at different times on the same lines. And first-generation logic analyzers, with their single-clock design, simply cannot demultiplex these correctly.

One popular solution to this problem has been to build a two-clock sequential acquisition system into a single package. While this approach will separate out address and read/write functions, it is still inferior to the 1610B. Why? Because this is still not true demultiplexing, in that this technique cannot correct for the real-time differential between the capture of address information and the capture of read/write data.

This means address and data information can be interleaved in the display. It requires the operator to interpret read or write functions. And it means that triggering may occur on false address/data combinations. In other words, it complicates analysis and may lead to false conclusions.

In comparison, the HP 1610B incorporates not two — but three clocks — plus a buffered memory to deliver true demultiplexing. In short, the 1610B can independently monitor addresses, plus read and write data, to demultiplex in real time for efficient and accurate analysis.

So with the 1610B, addresses and corresponding data are displayed as a single line of information, for easy comparison with your original programs. And you're sure that if you trigger on an address-data combination, the data is present at that address at that specific point in the program.

Other important capabilities.
In addition, the HP 1610B delivers other capabilities required for efficient state flow analysis of both bus structures. It will store information on a qualified basis, to permit selective editing. Which means you don't have to sort through unnecessary data. And it makes functional measurements, such as time interval analysis, on the state flow, which speeds analysis and troubleshooting.

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Because the 1610B is a 32-bit analyzer with user-selected parameters, and a variety of options, you can use it with both mini and micro based systems, including 8-bit microprocessors such as the Motorola 6800 and the Intel 8085, as well as the newer 16-bit microprocessors such as the Z8000. And, of course, it includes HP's popular menu program format that speeds set-ups and analysis.

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For complete details.
The HP 1610B is priced at $12,500,* while the 1611A (including the general-purpose module) is $6,000.* For more information on these, and for an application note on state analysis of multiplexed microprocessors, write: Hewlett-Packard, 1507 Page Mill Road, Palo Alto, CA 94304. Or call the HP regional office nearest you: East (201) 265-5000, West (213) 970-7500, Midwest (312) 255-9800, South (404) 944-1500, Canada (416) 678-9430.

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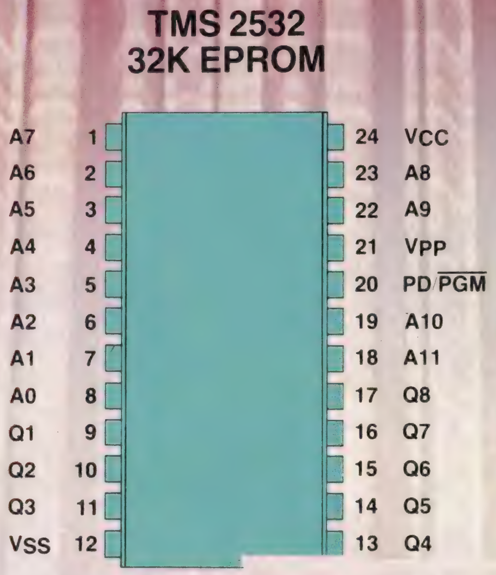

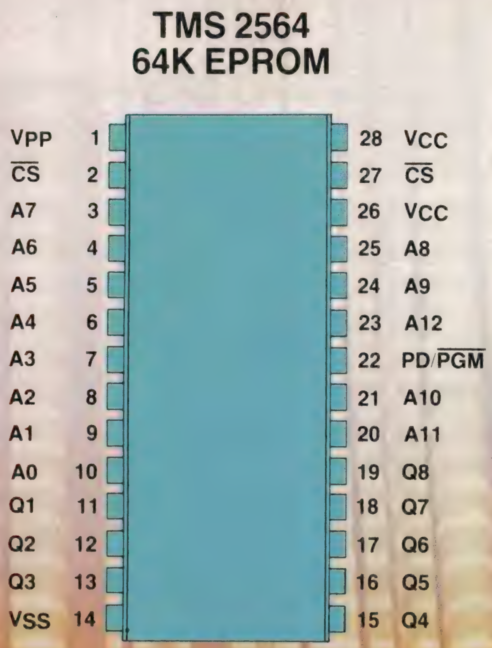

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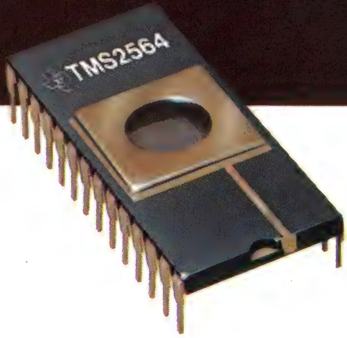

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TMS2516-35	16K	5 V	525 mW	131 mW	350 ns
TMS2516	16K	5 V	525 mW	131 mW	450 ns
TMS2508-25	8K	5 V	446 mW	131 mW	250 ns
TMS2508-30	8K	5 V	446 mW	131 mW	300 ns
TMS2716	16K	+12, ±5 V	720 mW	—	450 ns
TMS27L08	8K	+12, ±5 V	580 mW	—	450 ns
TMS2708	8K	+12, ±5 V	800 mW*	—	450 ns
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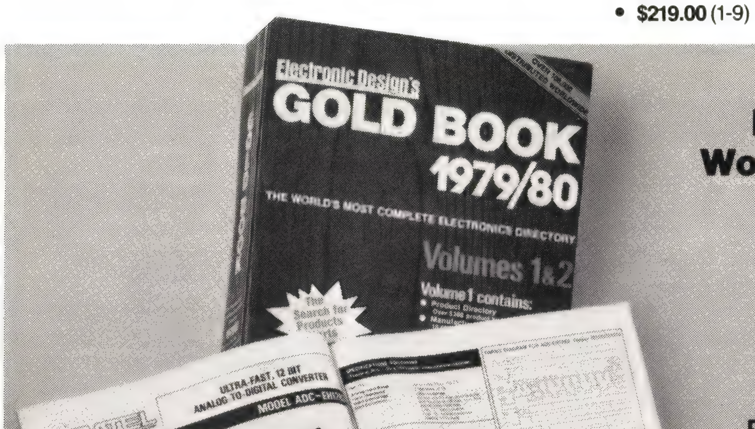
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CIRCLE NUMBER 56

The 8086 μP has the architecture to handle high-level languages efficiently

Designing a μP for *efficient* execution of high-level languages has been considered seriously only recently, but high-level capabilities like reliability and portability can exert exorbitant memory costs unless a μP is designed for it. For this reason, the 8086 has taken on architectural features that make it more suitable for executing high-level language (HLL) programs efficiently.

Programs written in HLL are rarely as memory-efficient as programs implemented with assembly language. But thanks to the HLL efficiency of the 8086, the PL/M-86 compiler increases memory requirements by no more than 1.45 times those of the ASM-86 assembler. The execution speed penalty is even less—only 1.19 times that of ASM-86 programs (depending, of course, on the compiler options and the applications).

What's more, the 8086 architecture permits PL/M-86 to work much more efficiently than high-level compilers—for example, it can reduce the size of entirely reentrant code as much as 54% when compared with the same code run through the PL/M-80 compiler.

More fringe benefits

Shorter object code not only saves memory space, but it executes faster since there are fewer instructions to fetch, decode and execute. In virtual memory systems smaller programs generate fewer page faults—system calls to fetch a page from auxiliary storage and bring it into main memory—and in multitasking operating systems, more small tasks can be active since more fit into system memory. This increases processor efficiency while decreasing the swapping of task programs from auxiliary storage.

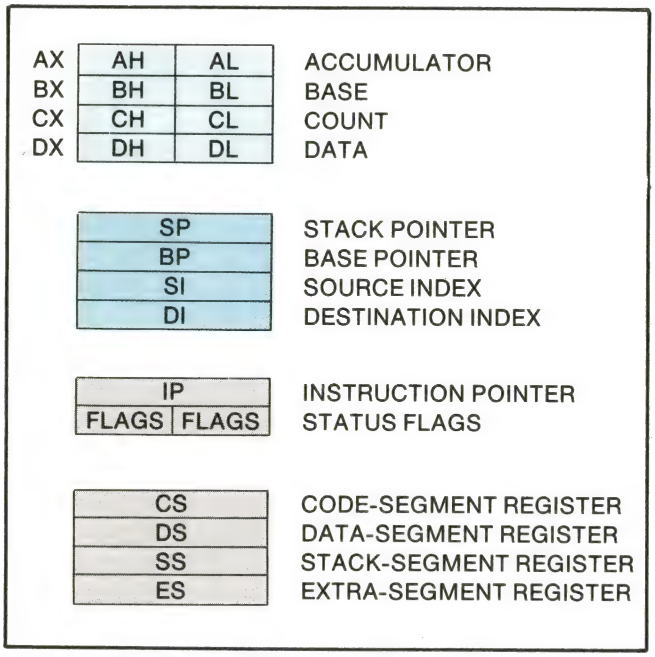
The 8086 uses the optimum amount of registers to implement high-level language efficiently. Based on 41 scientific DECsystem-10 programs, a study by A. Lunde reveals that three index registers and six registers all together are used 90% of the time.[1] The programs were coded in Algol, Basic, Bliss, two versions of Fortran, and assembly language.

The DECsystem-10 has 16 general registers. Complex IF and assignment statements require several registers to store temporary results while simple ones usually need only one register or none at all. Furthermore, well-structured programs often use procedure-call statements that store temporary results in registers. Because the called procedure can change the contents of these registers, it may be necessary to save them during the whole procedure—not a very effective approach. So, even in a register-rich environment, compilers will often keep variables in memory rather than exploit the additional registers. These are reserved primarily for temporary calculations and address manipulation.

The 8086, however, provides eight general registers (Fig. 1), four of which may be used as index registers—enough to support the required 90% usage. On the other hand, providing too many registers would increase the interrupt-service time.

Optimized op-code formats

The 8086 also gets high marks in handling the storage of constants. W.G. Alexander and D.B.



1. Some of the 8086 general-purpose registers (color) can be split into 8-bit registers (light shade). Segment registers (gray) permit dynamic memory management by partitioning the 1-Mbyte address space into 64-k modules.

Steven A. Lapham, Marketing Manager, and **Harold M. Kop,** Microprocessor Applications Engineer, Intel Corp., 3065 Bowers Ave., Santa Clara, CA 95051.

Wortman found that 95% of the time constants could be represented with 8 bits of data.[2] A look at the 8086 instruction set reveals how the μP applies these findings to generate memory efficient code.

First of all, instructions need not be "word-aligned"—i.e., multiples of 2 bytes. This allows the compiler to generate 1 or 3 bytes of code as well as 2 or 4. Second, byte-immediate fields can be used for small values—for example, adding a byte-immediate value to a word register of memory location requires only 1 byte to specify that immediate value. Before adding, the architecture automatically sign-extends the 8-bit immediate value to 16 bits so, whenever possible, only 1 byte of immediate data is included in the instruction rather than an entire word. The same principle permits addressing-mode displacement values of byte as well as word values.

In its general form, an instruction specifies register operands. But the 8086 also provides another form of the same instruction with an implied-register operand. These forms are 1 byte smaller and are commonly generated by HLL compilers: transfers between the accumulator (AL or AX) and memory; operations with the accumulator and immediate data (add, subtract, AND, OR), and many more.

In addition, all string instructions for the 8086 have implied-register operands. The SI and DI registers are operand pointers and the AL/AX and CX registers contain operands. Thanks to such implied registers, the code generated for the 8086 is quite compact.

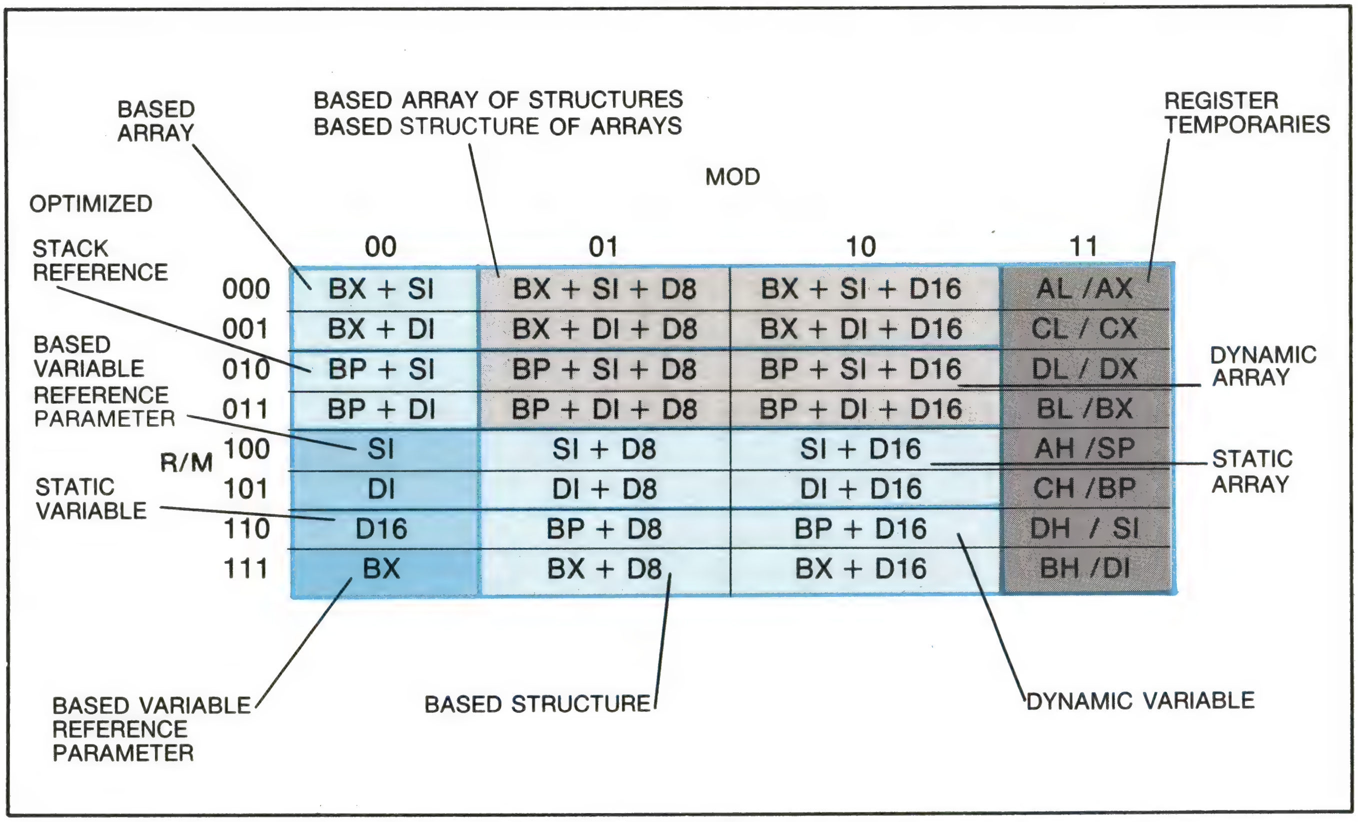
Some compact register instructions occupy only 1 byte of program memory—these include INC BX, DEC DI, PUSH BP, POP SP, and XCHG AX, DX (exchange registers). Note that the PL/M-86 compiler will automatically generate the shortest instruction no matter which input form is used.

Choice of addressing

The 8086 also provides all necessary addressing modes to support data manipulation in an HLL, from simple direct addressing to the complex base + index + displacement. Fig. 2 shows a matrix of 8086 address calculations, which can be subdivided into groups that identify support for the various data and structure types used by HLLs:

- Support of static variables uses a simple 16-bit displacement.
- The effective address for a variable within a dynamic array is calculated as the sum of a base register, an index register and a displacement.
- The calculated address is added to one of the segment registers to form the 20-bit physical address of the variable in memory, after the 16-bit segment register has been shifted left by 4 bits.

The registers and displacements used to calculate an effective address are encoded in the second byte within two fields of the instruction format (Fig. 3). There is a 2-bit mode field (MOD) and a 3-bit register/mode field (R/M); together they specify one operand while the REG field specifies the register operand. The direction bit, D, specifies the direction


BASED ARRAY
BASED ARRAY OF STRUCTURES
BASED STRUCTURE OF ARRAYS
REGISTER TEMPORARIES
OPTIMIZED STACK REFERENCE
BASED VARIABLE REFERENCE PARAMETER
STATIC VARIABLE
DYNAMIC ARRAY
STATIC ARRAY
BASED VARIABLE REFERENCE PARAMETER
BASED STRUCTURE
DYNAMIC VARIABLE

R/M \ MOD	00	01	10	11
000	BX + SI	BX + SI + D8	BX + SI + D16	AL / AX
001	BX + DI	BX + DI + D8	BX + DI + D16	CL / CX
010	BP + SI	BP + SI + D8	BP + SI + D16	DL / DX
011	BP + DI	BP + DI + D8	BP + DI + D16	BL / BX
100	SI	SI + D8	SI + D16	AH / SP
101	DI	DI + D8	DI + D16	CH / BP
110	D16	BP + D8	BP + D16	DH / SI
111	BX	BX + D8	BX + D16	BH / DI

2. To support different types of data and structures efficiently, HLLs require many addressing modes. Decoding of the MOD and R/M fields (Fig. 3) provides the 8086 needed range of modes, from fixed displacement (deep color) to base + index + displacement (light gray). Colored lines separate the 11 different modes.

of the operation: D=0 signifies operation from, and D=1 operation to the register. (Advantages of this symmetry between memory and register will be discussed further.)

Both 8 and 16-bit registers and memory operands in the 8086 are facilitated with an additional word/byte bit, W, contained within the first byte of the instruction format. So while supporting all the necessary variable types, HLL compilers are able to generate much more efficient code than can be generated for other architectures. As a result, the encoding scheme is quite compact.

Special support of procedure calls

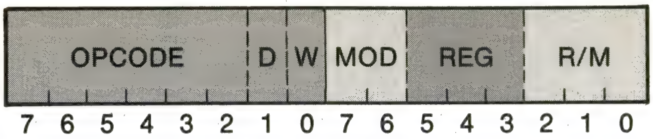
Another 8086 strong point is its special handling of procedure calls, which typically make up 13 to 25% of the statements in a well structured HLL program.[3]

Most HLLs store local procedure variables on the stack, which allows the procedure to be both reentrant and recursive. (Reentrant procedures can be used by more than one program without having to create a separate copy for each program; recursive procedures can call themselves and thus greatly simplify the coding of some algotithms.) Storing local variables on the stack also means more efficient RAM use, since storage is allocated dynamically during execution time rather than statically during compiling.

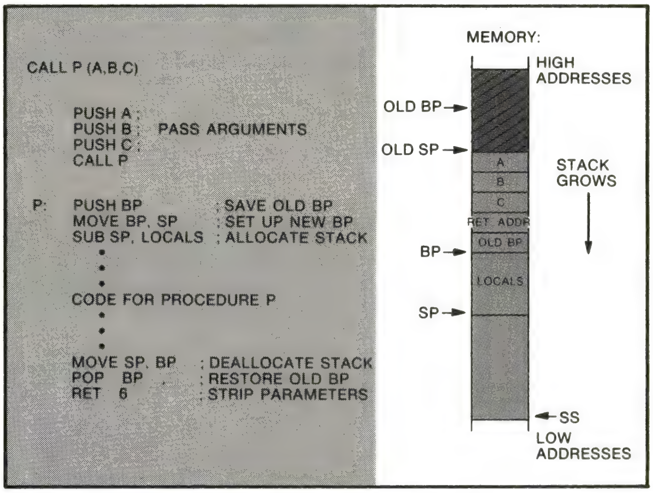
The 8086 provides efficient stack management for implementing reentrant and recursive procedures. All parameters are passed on the stack, and local variables are stored there, as shown in Fig. 4. The based addressing mode, using the BP register (MOD =01 or 10 and R/M=110), allows easy access to all the scalar variables and structure elements on the stack. On the other hand, array elements on the stack, whether passed parameters or local variables, are more efficiently accessed by the base + index + displacement addressing mode (MOD=01 or 10 and R/M=010 or 011).

After return from a procedure, parameters are easily removed from the stack with the RET n instruction; the constant n is added to the stack pointer to remove the passed parameters. Without such stack-pointer manipulation a program with numerous reentrant and recursive procedures could consume a large amount of overhead just to remove parameters from the stack. But if properly used, the powerful 8086 RET instruction can save substantial program memory and increase execution speed, to boot.

Assignment statements also get special treatment from the 8086. They ought to—they represent half the executable statements.[3] Of these, 20% assign a constant to a variable, 15% involve two right-hand terms, and 10% assign one variable to another.



3. **Compact encoding characterizes 8086 two-operand instructions. The right-hand byte identifies the register used for one operand and determines the addressing modes (light color). If MOD = 11, the R/M field is a register; otherwise the effective address is a memory location.**



```
CALL P (A,B,C)

         PUSH A ;
         PUSH B ;   PASS ARGUMENTS
         PUSH C ;
         CALL P

P:       PUSH BP               ; SAVE OLD BP
         MOVE BP, SP           ; SET UP NEW BP
         SUB SP, LOCALS        ; ALLOCATE STACK
            •
            •
            •
         CODE FOR PROCEDURE P
            •
            •
            •
         MOVE SP, BP      ; DEALLOCATE STACK
         POP   BP    ,    ; RESTORE OLD BP
         RET   6          ; STRIP PARAMETERS
```

4. **A PL/M procedure call (gray) sets up the stack area to pass parameters and store local variables. When the procedure is completed, MOVE and POP clean up the parameters and RET returns control to the calling program.**

The 8086 provides single instructions that perform basic operations (e.g., add, subtract, AND, OR) between memory-based variables and constants, or between register contents, and then return the result to memory. The code generation is greatly simplified, compared with the generation possible with earlier minicomputer architectures, which required first operations on registers and then another instruction to move the result back to memory. For example, consider adding an operand contained in the AX register to a memory-based variable referenced by the SI or DI register. Taking advantage of the memory symmetry, the 8086 code

```
ADD VAR (SI), AX
```

is 2 bytes long and executes in 21 clock cycles. Without memory symmetry, it would be necessary to write 6-byte code—taking 30 clock cycles to execute:

```
MOV BX, VAR (SI)
ADD BX, AX
MOV VAR (SI), BX
```

All things considered, the 8086 architecture provides a clean and efficient environment for executing high-level language programs.■■

References

1. Lunde, A., "Empirical Evaluation of Some Features of Instruction Set Processor Architectures," *Comm. ACM,* March, 1977, pp. 143-153.

2. Alexander, W.G., and Wortman, D.B., "Static and Dynamic Characteristics of XPL Programs," *Computer,* November, 1975, pp. 41-46.

3. Tanenbaum, A.S., "Implications of Structured Programming for Machine Architecture," *Comm. ACM,* March, 1978, pp. 237-246.

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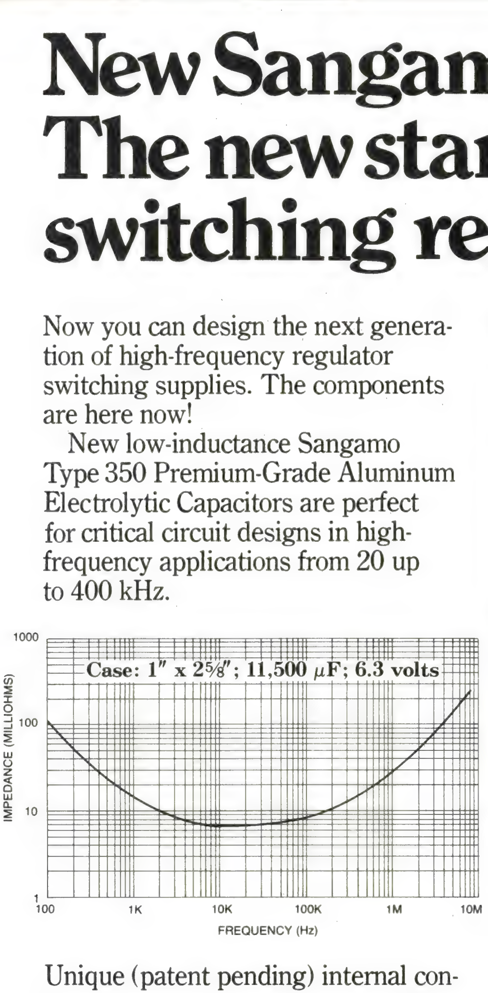

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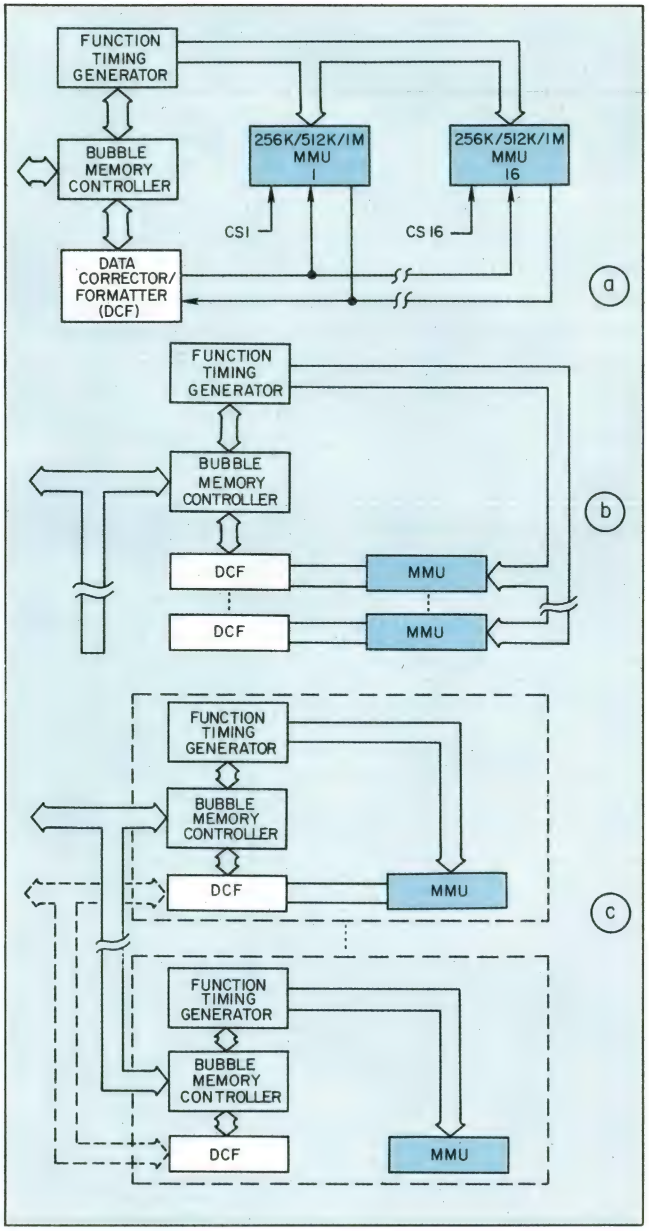
Developed by Texas Instruments for the TIB1000 family of bubble memory components (Electronic Design, Nov. 22, 1979, p. 156), BMAC gives the user unusual freedom in configuring systems, whether one bubble memory device is involved or a large array. The support circuits (such as sense amplifier, read and write function drivers and coil drivers) have a TTL-compatible interface to simplify system design.

A bubble-memory system can be configured in any one or a combination of the three directions, X, Y or Z. The three diagrams in Fig. 1 show the various expansion capabilities in each axis. With expansion in the X axis, up to 16 modular memory units (MMUs) may time-share a DCF circuit. Even more MMUs can be added to the system with the addition of TTL-buffer gates. Each MMU consists of the bubble-memory device and the immediate support circuits (see "Inside the MMU").

I/O lines from the host processor system control the chip-select lines common to all interface circuits within the MMU. When the memory system is expanded only in the X direction, data are normally routed from the DCF to the TIB0904 controller. Because the pages of data are buffered in the DCF, they transfer at a 1-MHz burst rate to the controller. The data then rapidly fill the 8-bit accumulator that interfaces to the 8-bit data bus of the host system.

Change directions and boost throughput

When faster data throughput is needed, the memory system expands in the Y direction by adding DCF circuits. The number of channels available for system



1. The bubble memory system expands in any of three-axis directions—X Y and Z. For expansion along the X-axis, this scheme (a) multiplexes the DCF between several MMUs. Giving higher throughput, expansion along the Y axis (b) increases the number of data channels, with one DCF per channel. For the maximum system throughput, the system expands in the Z axis (c), multiplexing several controllers on the host system bus. This scheme allows continuous high-speed data transfers.

Gerald Cox, Engineering Manager, Magnetic Bubble Memory Systems, Texas Instruments, P.O. Box 5200, MS 997, Dallas, TX 75222.

expansion equals twice the number of 1-Mbit bubble memory devices (for example, two channels in a system with one 1-Mbit device).

The TIB0904 controller receives information from one, two or four DCF circuits in parallel and reformats it into 8-bit parallel data to interface to the microprocessor. For larger configurations, the data I/O lines to the DCF bypass the controller and connect directly to the host-system data bus. The controller can manipulate any number of parallel channels, but 64 channels is normally a practical limit. (For odd numbers of channels, a TIB0500 bubble memory device can be mixed with the TIB1000 system configuration.) In a 32-bit-wide system, the maximum burst data rate is 16 Mbytes/s. With the data pages double-buffered in the DCF, up to 512 bits of error-corrected data burst simultaneously into the host system at speeds up to 4 Mbits/s per channel.

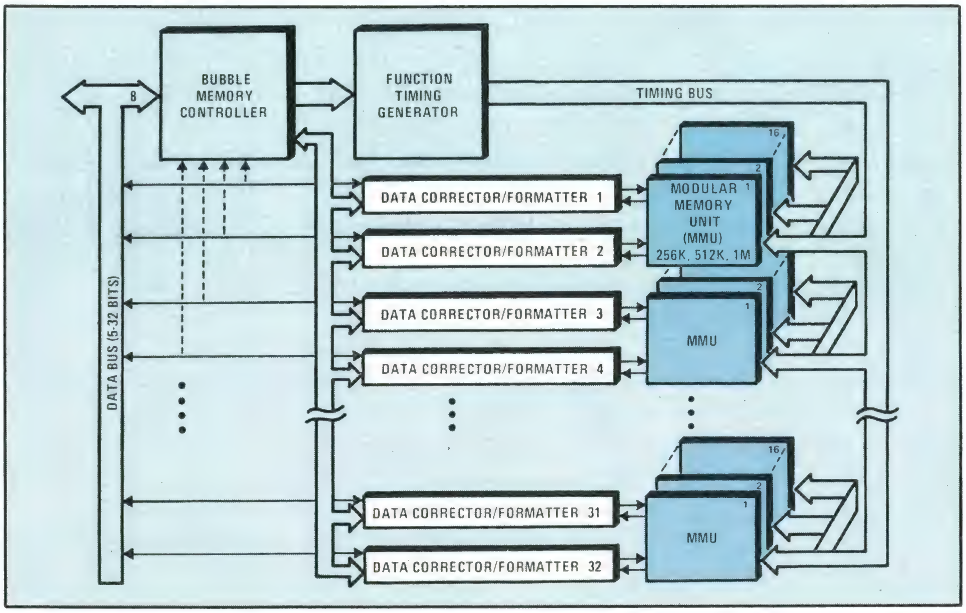
For even higher data throughput, the memory system expands in the Z dimension. The entire basic system is multiplied until the number of buffers in the DCFs allows continuous operation to and from the host system. A chip-select input to the DCF and controller decouples each memory subsystem from the host system bus, without interrupting reading and writing into the bubble memory. Thus, data are processed even while the host system goes on to the next memory subsystem and continues to read or write data into its DCF data buffers.

Yet another type of system expansion (Fig. 2) combines the X and Y dimensions. Each vertical column of MMUs operates in parallel, to provide a 32-bit-wide data bus with a transfer rate of 16-Mbytes/s. The columns, in turn, multiplex via a chip-select line to the DCF and MMU subsections.

The maximum system expansion employs all three axes (X, Y and Z). As shown in Fig. 3, 16 or more memory planes (Fig. 2) share a common address and data bus to the host system. The memory planes multiplex via chip-enable lines; the total system capacity shown is 256 Mbits per memory plane, times 16 banks—equals 4096 Mbits, or 512 Mbytes. Each DCF has a buffer capacity of 512 bits (with error correction); and a 32-bit wide data bus lets the system read or write 2048 bytes of data before the DCF is emptied. Assuming a 200-kHz field frequency, the average access time for this system would be just 5.6 ms.

Interfacing to the host system

After the system architecture is designed, the interface to the host system needs consideration. Data can be read or written in three ways: with interrupt, by direct-memory accesses (DMA) or with a polled I/O. The bubble-memory controller appears to the CPU as seven registers, which are accessed by the Chip-Select, Address, Read and Write signals. The seven controller registers are command, status, error status, parameter, results, read data and write data. Various other control signals (such as Interrupt, DMA Request and DMA Grant) are also available for various system configurations.


BUBBLE MEMORY CONTROLLER
FUNCTION TIMING GENERATOR
TIMING BUS
8
DATA BUS (5-32 BITS)
DATA CORRECTOR/FORMATTER 1
DATA CORRECTOR/FORMATTER 2
DATA CORRECTOR/FORMATTER 3
DATA CORRECTOR/FORMATTER 4
DATA CORRECTOR/FORMATTER 31
DATA CORRECTOR/FORMATTER 32
MODULAR MEMORY UNIT (MMU) 256K, 512K, 1M
MMU
MMU
16
2
1

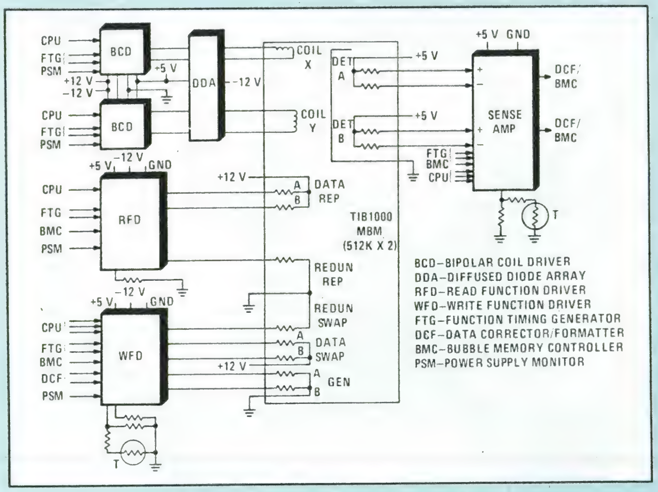
2. When a memory system expands along the X and Y axes simultaneously, up to 32 or more bubble-memory channels may interface to the controller. This particular scheme would accept 16 Modular Memory Units for every two DCF circuits, for a total storage capacity of 256 Mbits.

Inside the MMU

The modular memory unit (MMU) consists of the bubble memory device and its associated direct-support components, including the read and write-function drivers, the coil drivers and the sense amplifier. These circuits are added on a one-to-one basis, for each bubble memory device used in a system.

As shown in the figure, for the TIB1000 magnetic bubble memory device, two coil driver circuits and a diode array combine to shape the waveform for the coils. Additionally, the read-function driver and the write-function driver control the replicate, swap and generate functions of the bubble memory device. The detector outputs are fed into the dual-channel sense amplifier that uses a phase-tolerant sensing scheme to detect the bubble's presence or absence and to provide the dual data channels to the data corrector/formatter. The sense-amplifier circuit also shares a thermistor input from the right function driver which senses the temperature of the bubble memory device and adjusts the amplifier gain accordingly.

All of the support circuits for the bubble memory device are controlled by inputs from the function timing generator, the data corrector/formatter, the host system CPU and the power-supply monitor circuit. The special power-supply monitor circuit built into the host system makes sure that all the function drivers and coil drivers are enabled or disabled at the same time. This circuit can also detect when supply levels have dropped below 95% of their nominal value, and thus warn the user that a power failure is imminent.

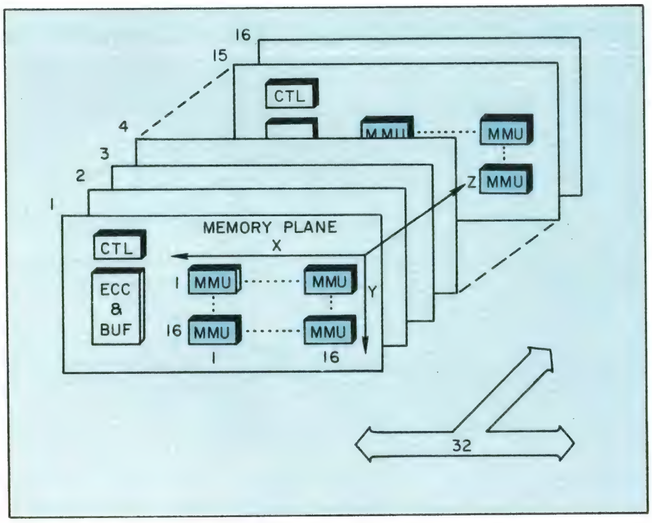


In the interrupt mode, the controller's interrupt section activates the interrupt line when a data buffer is ready for transfer. An active interrupt line indicates that data can be transferred to the host system during a read operation or that a data buffer is empty, so that data can be transferred from the host system to the buffer during a write operation. The interrupt line is also activated at the end of an operation.

DMA operations are generally required if eight or more devices are operated in parallel, because of the fast data rate (more than 100 kbytes/s). For DMA operations, an external DMA controller gives the sequential memory addresses and timing for the data transfers. The number of bytes transferred in a DMA burst and the length of the interval between bursts are both programmable, making for efficient utilization. The bubble-memory controller and the DMA controller communicate through DMA Request and DMA Grant signals; the actual byte transfers are clocked by the Read and Write signals.

Put the controller in command

If DMA transfers are not used, the host system must either respond to interrupts or poll the status register of the controller to determine when a byte is ready for transfer. Then, the host system accesses each data byte that is ready and transfers it to or from the system memory. The controller contains an automatic halt so that the host system does not have to prevent the data buffers from overflowing or from underflowing.



3. An expansion along all three possible axes increases the maximum system-storage capacity to 512 Mbytes or beyond; the transaction block size swells to 1024 bytes; and the transfer rate goes to 16 Mbytes/s. The access time averages 11 ms.

The controller offers many commands, including a Read Address-Seek and Write Address-Seek. Virtual addressing is used exclusively, as in previous controllers; and two copies of the map data are stored in the bubble memory device. If the controller and DCF find either copy to be in error, a simple two-command sequence rewrites the map loop in the bubble memory with no loss of either address positions or data in the minor loops.

Additional controller commands simplify data transfers and determine the status of the system. Such commands control reading and writing the redundancy RAM; enabling reporting of detailed error status; initializing the controller, DCF and bubble-memory parameters; and setting the DMA mode. During system initialization, the Restore command synchronizes the bubble-memory module and reads the redundancy map from the bubble memory to the redundancy RAM in the DCF. In parallel systems, all MMUs in the Y and Z directions are initialized simultaneously. Only in the X direction must the MMUs be initialized sequentially, since the DCF contains RAM storage for only one map. In this case, the maps may be stored in a table in the host-system RAM.

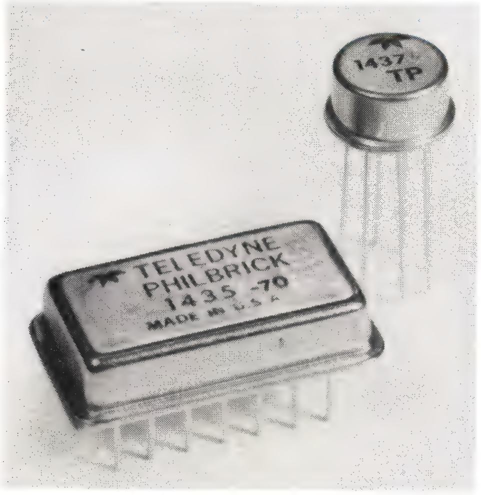
Although the maximum data rate for the TIB1000 is 160 kbits/s, data can transfer between the DCF and the host system at a maximum rate of 4 Mbits/s. In expanded systems, with 16 bubble memory devices operating in parallel, the data rate reaches 16 Mbytes/s. Although the individual devices in this example read or write 32 bytes during a DMA operation, the system configuration with 32 DCF channels has a transaction block size of 1024 bytes.

In addition to the command control feature, the DCF has an error correction code that keeps the error rate extremely low, just 3 × 10^{-15} errors per bit. So few errors go undetected that the mean time between incorrect or undetected errors for four bubble memory devices running in parallel is at least four years, and typically many times that (100-kHz field rate and 100% duty cycle).

For evaluation and OEM purposes, two board-level products, the TBB5005 with half-megabit devices and TBB5010 with megabit devices are available on a 4 × 6-in. compatible board, having all support ICs. Additionally, a TM990-microcomputer-compatible memory subsystem, with a 6-Mbit (TM990/211) storage capacity, offers all support ICs and a TMS9900 CLU interface. All the 4 × 6-in. cards will interface to the bus of almost any microprocessor system, since the appropriate support logic and address decoding are also contained on board.■■

How useful?	**Circle No.**
Immediate design application	**556**
Within the next year	**557**
Not applicable	**558**

Low Cost, High Performance Operational Amplifiers



1435-70	**High Gain Bandwidth**	**1 GHz**
	High Slew Rate	**300 V/µs**
	Unity Gain Bandwidth	**150 MHz**
	Very Fast Settling	**70 nsec to 0.01%**
	Full 5 V, 10 mA Output	
	Low Cost: $49.00 (100's)	
1437	**High Gain Bandwidth**	**350 MHz**
	High Slew Rate	**300 V/µs**
	Wide Operating Bandwidth	**40 MHz**
	Fast Settling	**110 nsec to .1%** **150 nsec to .025%**
	Full 10 V, 20 mA Output	
	Low Cost: $38.00 (100's)	

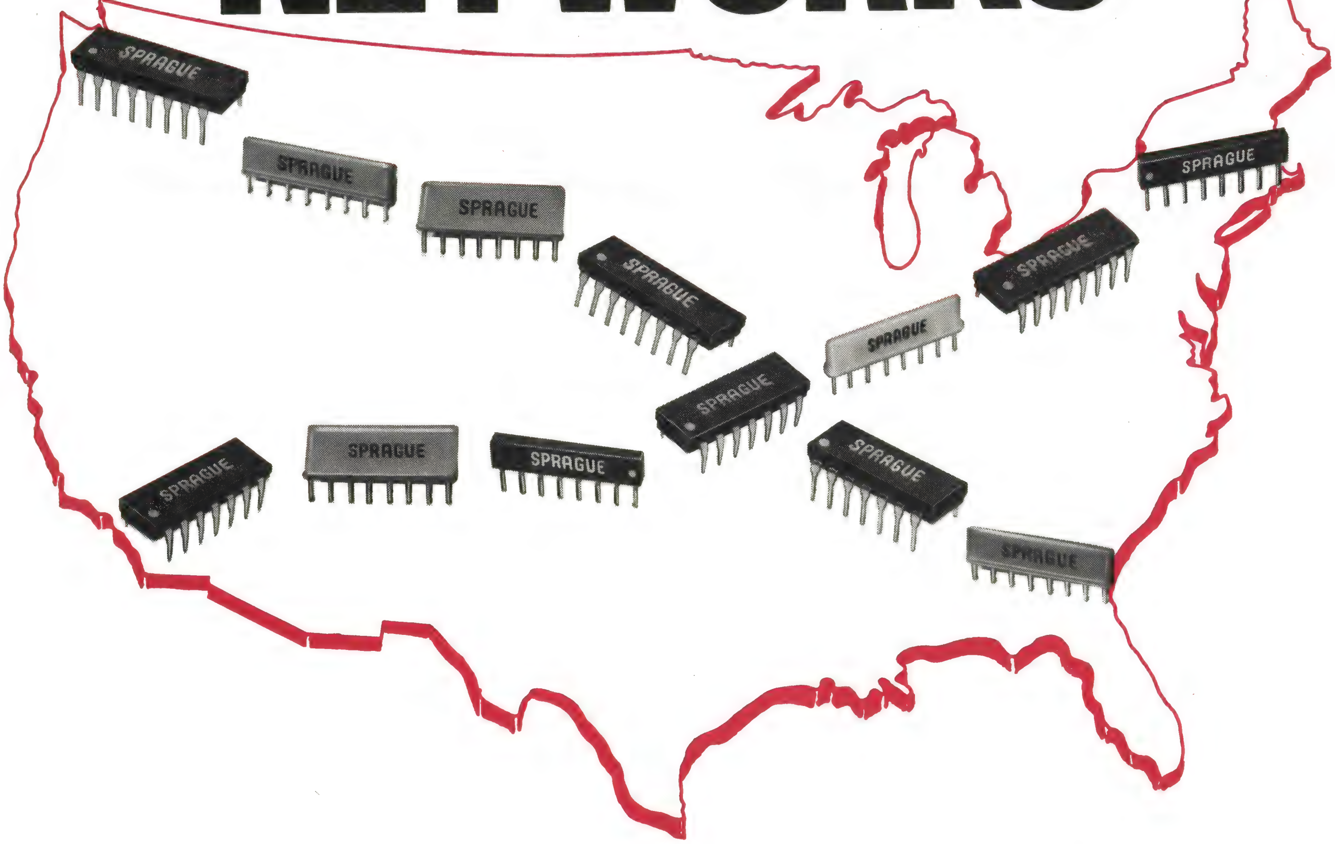
These new commercial (0°C to +70°C) hybrid operational amplifiers offer a price/performance ratio that's hard to beat! The choice of a single external compensation capacitor gives designers versatility in wideband steady state and fast transient applications. The 1435-70 and 1437 are also available in full temperature (−55 °C to +125 °C) and MIL-STD-883 versions.

TELEDYNE PHILBRICK

Allied Drive at Route 128, Dedham, Massachusetts 02026
Tel: (617)329-1600 TWX:(710)348-6726 Telex: 92-4439

CIRCLE NUMBER 59

COAST-TO-COAST NETWORKS



Solve your resistor network delivery problems by calling your Sprague sales office or stocking distributor.

Sprague supplies the DIP and SIP resistor networks required by customers like you. This table, listing just a few of the more-popular devices, shows how Sprague cross-references with other well-known suppliers.

Description	Allen-Bradley	Beckman	CTS	SPRAGUE
Multiple Isolated 14 Pins, 7 Resistors	34B . . . 4 314B . . .	899-3-R . . .	760-3-R . . .	**914C . . . X2SR**
Multiple Isolated 16 Pins, 8 Resistors	36D . . . 4 316B . . .	898-3-R . . .	761-3-R . . .	**916C . . . X2SR**
Pull-up/Pull-down 14 Pins, 13 Resistors	34A . . . 4 314A . . .	899-1-R . . .	760-1-R . . .	**914C . . . X2PE**
Pull-up/Pull-down 16 Pins, 15 Resistors	36C . . . 4 316A . . .	898-1-R . . .	761-1-R . . .	**916C . . . X2PE**
Thevenin Terminator 14 Pins, 24 Resistors	34E 4 314E	899-5-R . . . / . . .	760-5-R . . . / . . .	**914C . . . X2TR**
Thevenin Terminator 16 Pins, 28 Resistors	36E 4 316E	898-5-R . . . / . . .	761-5-R . . . / . . .	**916C . . . X2TR**

4SR-8118R2

For your nearest Sprague sales office, call Jim Fitzgerald at Sprague Electric Co., Tel. 413/664-4411. For your nearest Sprague stocking distributor, call Sprague Products Co. Division, Tel. 413/664-4481.

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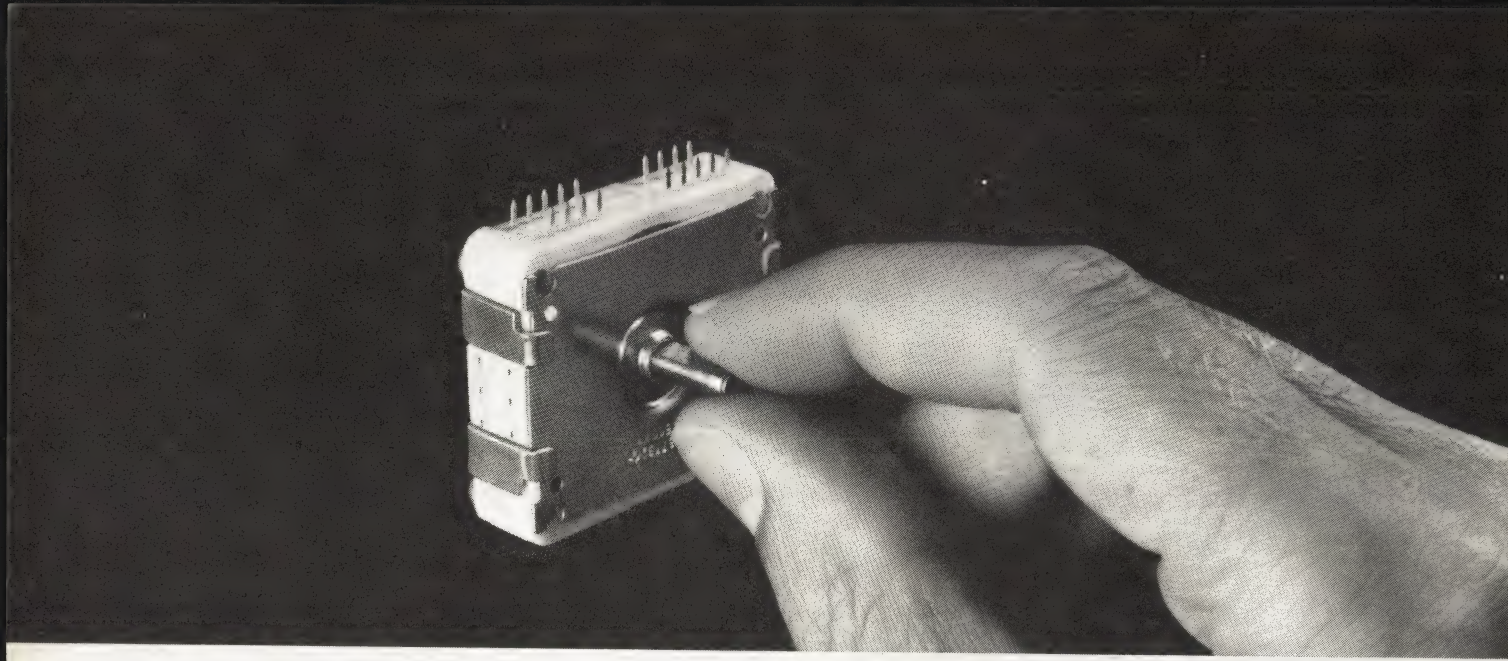
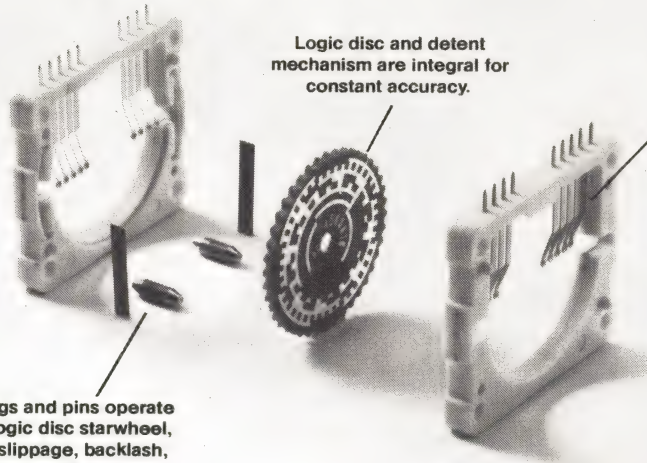


New twist on an old idea sets new accuracy standards in digital logic switching.



Logic disc and detent mechanism are integral for constant accuracy.

Plated copper terminals and contacts insert molded in 94V-0 thermoset for perfect positioning. Eliminates soldering and assembly problems.

Detent springs and pins operate directly on logic disc starwheel, eliminating slippage, backlash, inaccurate positioning.

As many as 4 digital logic switches may be ganged to increase the capacity of functions.

CTS Series 230 digital rotary switches assure accuracy in two important areas. First, contacts are insert molded securely in thermoset modules... not soldered or clipped in place. The one-piece molded design eliminates the mechanical shifting of contacts/terminations. And second, the detent mechanism is part of the logic disc for foolproof positioning.

Engineering imagination is just about the only limiting factor in using this problem solving switch. 40 detent positions are standard, but up to 50 are optional. And units may be ganged to increase the number of functions. Logic disc codes are anything you can devise using a maximum 8 level truth table per switch section.

While one side of the logic disc is programmed for switching functions, the other side can have a 7 segment code to operate LED's or LCD's. And at a cost of about $2, a CTS digital logic switch may well be an answer in search of a problem.

For technical information, circle the Reader Number. Or **for a free 7 digit readout sample, write on your letterhead** and indicate the use you contemplate for a CTS digital logic switch. Write CTS of Elkhart, Inc., 1142 West Beardsley Avenue, Elkhart, IN 46514. (219) 295-3575.

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CTS ®

CIRCLE NUMBER 61

Snap-action thyristor control circuit stabilizes relay pull-in and drop-out

A special on-off thyristor control circuit, when used with a relay/transformer such as the TRAN-TROL type 3 or the ALCOSWITCH types FRE103 or FR102, will provide reliable, chatter-free relay operation, no matter how slowly the control resistance varies. In fact, inductive loads of many types (solenoids, relays, etc.) can be reliably controlled with this circuit.

To construct the circuit (see Fig.), reverse the series connection of the resistor (R_c) and the capacitor (C) normally used as a snubber circuit around a thyristor with an inductive load; then connect the thyristor gate to the junction of R_c and C. The thyristor can be made to toggle between its fully conducting (on) and fully blocked (off) states as R_c is slowly varied through the operating points.

Since the value of R_c required for thyristor turn-on is greater than the value required for turn-off, the overlapping operating points produce a hysteresis band. Its width can be varied by putting a second resistor, R_p, in parallel with C and adjusting the values of R_p and C. This hysteresis band assures that the thyristor will remain in one state or the other until the value of R_c passes through the opposite operating point. (Sometimes it may also be necessary to insert a resistor, R_s, in series with the thyristor gate to limit, the gate current.)

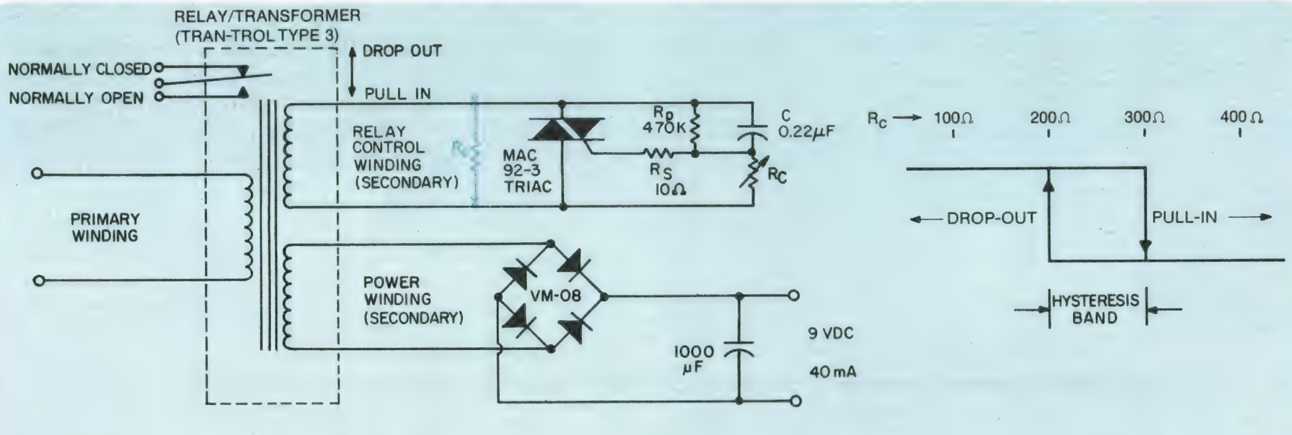
A typical application for the TRAN-TROL and ALCOSWITCH units would be a low-voltage sensor system, isolated from the power line, for a perimeter security alarm. Here, sensors, which are represented by R_c in the figure, form a series circuit of magnetically-actuated contacts at doors and windows. A photocell in parallel with these contacts arms the circuit at dusk and disarms it at dawn.

The TRAN-TROL power winding (secondary) provides a source of low-voltage power to operate delay timers or other low-power ac and dc circuits and devices associated with the security application. High-power circuits (alarms) use the relay contacts, which are open or closed as determined by the relay's control secondary winding current.

The reliable relay armature transition obtained with the thyristor circuit (as opposed to simply placing R_c across the TRAN-TROL's relay control secondary) also makes longer sensor circuit loops practical. However, normal precautions should be exercised on long loops to minimize extraneous noise pickup.

John J. O'Farrel, Jr., President, The TRAN-TROL Company, Tucson, AZ 85712.

CIRCLE NO. 311



When R_c, connected directly across the relay/transformer's control winding (color connection), changes slowly, the result is unstable relay operation (chatter) before the electromechanical contacts pull-in or drop-out. But when R_c controls a thyristor placed across the control winding, the results are better: a small, sharply defined hysteresis band is formed and pull-in and drop-out are determined only by the thyristor's two stable states, conducting or blocked.

Divide symmetrical clock pulses by odd numbers, get a symmetrical output

If the available input clock frequency is symmetrical (50% duty cycle), then a pulse generator, divide-by-N counter and flip-flop can divide it by an odd number (N) and produce a symmetrical output. Although cross-coupled one-shots (see reference) can also give a symmetrical output for this application, it is generally preferable to avoid one-shots and use a fully clocked design: When divisor N is large, error margins for the one-shots are small.

Suppose that a division-by-7 is desired. With the circuit of Fig. 1, the input clock is applied to the pulse generator (R, C and EXCLUSIVE-OR gate U1). As the clock pulse changes state, either from 1 to 0 or from 0 to 1, input lead 1 of U1 follows the change immediately; but, because of the RC network, lead 2 does not. (The RC network is chosen so that the voltage on lead 2 trails the voltage on lead 1 by a fraction of the clock interval.) The output of the EXCLUSIVE-OR gate (B) is a pulse at each transition of the input clock. This pulse rate is double the input clock rate (see Fig. 2).

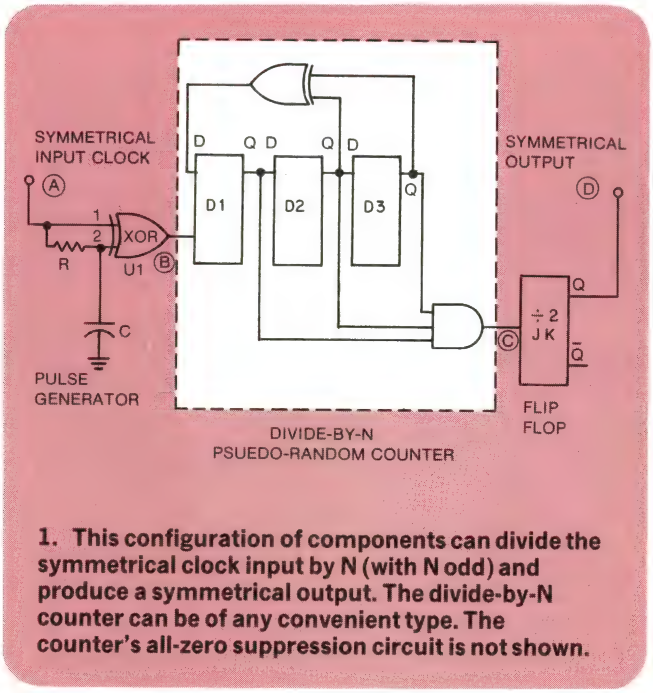
The counter which performs the "divide-by-N" function is driven by the pulse train produced by U1. This counter is not critical and can be any convenient type that will yeild the desired value of N. Because of the increased clock rate at B (with respect to A), the output of the divide-by-N counter is twice as fast as desired. Following the counter with a divide-by-two flip-flop produces the desired frequency and also provides a symmetrical output waveform.

Reference

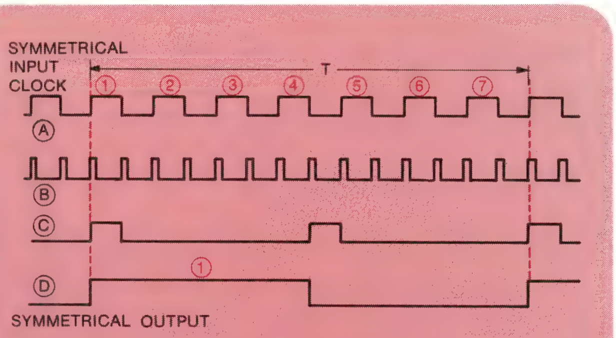
Madni, A.M., "Cross-coupled One-shots Divide by Odd Numbers and Give a Symmetrical Output," ELECTRONIC DESIGN, Oct. 25, 1979, p. 114.

Lawrence E. Getgen, Senior Staff Engineer, GTE Lenkurt Inc., 1105 County Rd., San Carlos, CA 94070.

CIRCLE NO. 312

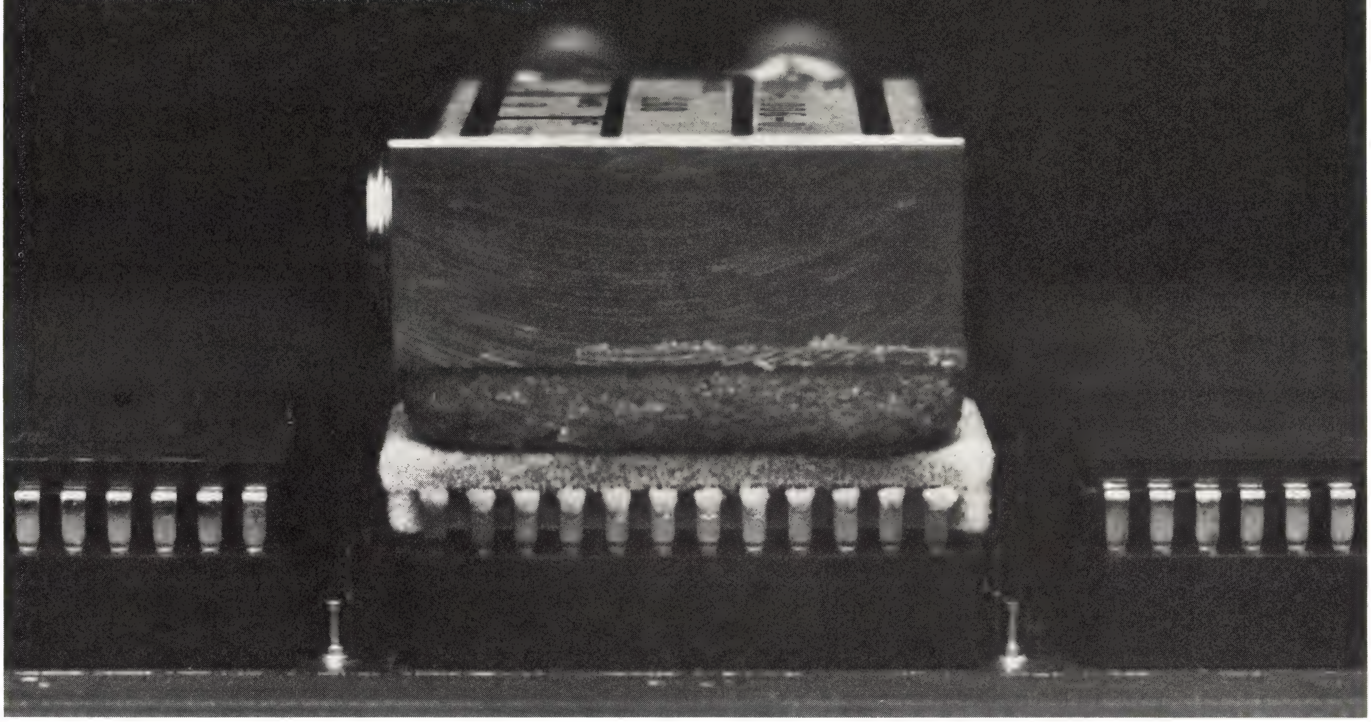


1. This configuration of components can divide the symmetrical clock input by N (with N odd) and produce a symmetrical output. The divide-by-N counter can be of any convenient type. The counter's all-zero suppression circuit is not shown.



2. These waveforms apply to the circuit of Fig. 1 when N = 7. An examination of period T shows that seven symmetrical clock pulses have been "divided" into one symmetrical output pulse.

Many Electronic Design Problems Could Benefit From a Little Cool Thinking



Herewith are a few modest examples:

Circuit miniaturization:
Often, power dissipation is the limiting parameter in electronic circuit miniaturization. *Solution:* Actively pump the heat out of the circuit package.

Hot environments:
Circuits operating in hot environments overheat and malfunction. *Solution:* Refrigerate these circuits. Cool them to acceptable operating levels.

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Amplifiers are noisy at high temperatures and, in some, critical parameters drift, excessively, with temperature change. *Solution:* Regulate amplifier operating temperature to a fixed, cool level.

But design philosophy is not all we have to offer. We have the hardware too. They're called thermoelectric modules. Sandwiched between your circuit package and a suitable heat sink, the thermoelectric module can heat or cool your electronics package and keep it at any preset operating temperature in the range of ambient ±70°C.

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CIRCLE NUMBER 62

Pulse transformer eliminates power transformer in PWM dc controller

A pulse-width modulated (PWM) controller for dc loads does not need a large power transformer to isolate the IC control logic and signal processing circuits from ac voltage levels and line transients. Instead, a full-wave diode bridge and some filter capacitors will rectify the raw incoming ac into dc power, referenced to a floating ground (see Fig.) A small pulse transformer (Pico or Triad type) gives the isolation needed between the power-handling circuit and any control-signal sources referenced to the chassis ground.

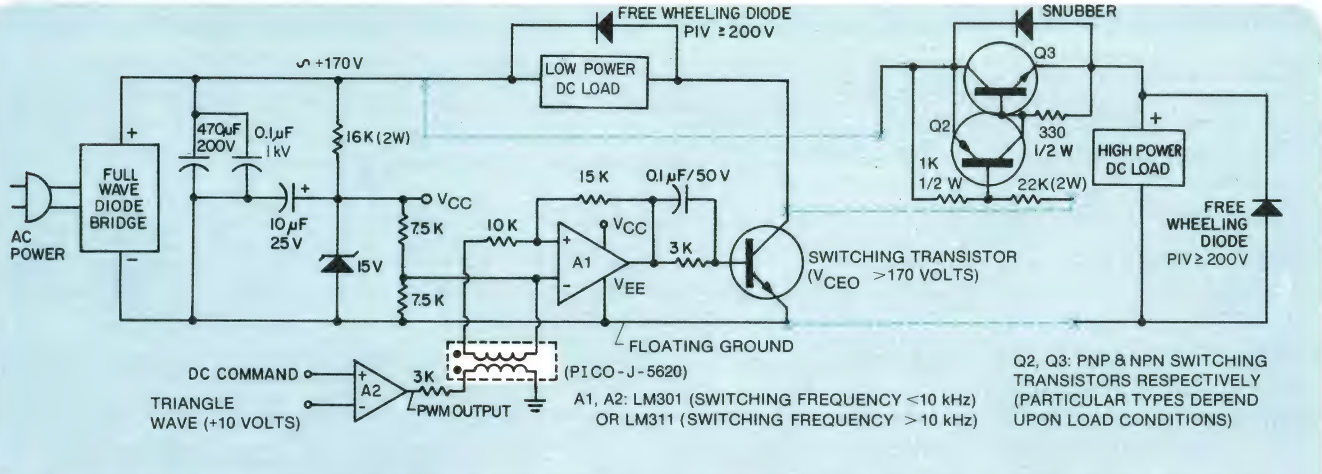
The floating driver (R_1, R_2, Q_1 and comparator A1) is a positive Schmitt trigger with symmetrical thresholds, set by the ratio R_1/R_2 times one-half the saturation voltage of A1's output about the 7.5-V floating reference. These thresholds are determined by the turns ratio of transformer T_1 and the input energy sensitivity of comparator A1.

Power for A1 is derived from the diode bridge and regulated by Zener D_3. (The power transistor Q_1, for switching current through the dc load, and its adjacent circuits are referenced to the same floating ground as the diode bridge.)

Pulse width modulation waveforms from A2 are converted to voltage spikes on T_1's secondary. Thus, the Schmitt trigger switches on and off with a duty cycle equal to that appearing at A2's output.

Christopher S. Tocci, Analog/Biomedical Engineer, Becton-Dickinson Medical System, Westwood, MA 02090.

CIRCLE NO. 313



A pulse transformer provides isolation between small-signal control circuits (inputs to A2) and ac-power line voltages, since this dc controller has no power transformer. High-power dc loads may be handled by breaking the circuit at the three points indicated and exchanging hookups.

IFD Winner for November 8, 1979

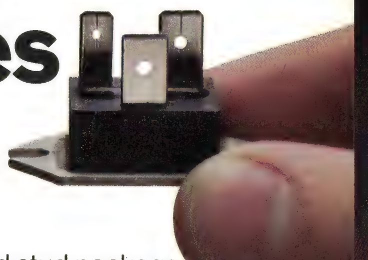
H. Ralph Wilbur, Electronic Engineer, Leach Corp., 5915 Avalon Blvd., Los Angeles, CA 90003. His idea "Filter Gain Is Adjustable Using a Simple Resistance Ratio" has been voted the Most Valuable of Issue Award.

Vote for the Best Idea in this issue by circling the number for your selection on the Reader Service Card at the back of this issue.

SEND US YOUR IDEAS FOR DESIGN. You may win a grand total of $1050. Here's how. Submit your IFD describing a new and important circuit or design technique, the clever use of a new component or test equipment, packaging tips, cost-saving ideas to our Ideas for Design editor. Ideas can only be considered for publication if they are submitted exclusively to ELECTRONIC DESIGN. You will receive $20 for each published idea, $30 more if it is voted best of issue by our readers. The best-of-issue winners become eligible for the Idea of the Year award of $1000.

ELECTRONIC DESIGN cannot assume responsibility for circuits shown nor represent freedom from patent infringement.

Easy to mount. Easy to connect. The RCA 25 amp triac comes in a rugged new package.



Our new QuikOn triac package is designed for high-speed assembly line installation.

Top side terminals let you do all your mounting from one side, with fast self-tapping sheet metal screws. The device can handle 300 amps surge current. 2500 volts isolation from any terminal to flange makes isolation hardware unnecessary.

Plus, we used quick-connect terminals that let you use solderless snap-on connectors.

All of which can add up to lower assembly costs than with conventional stud packages.

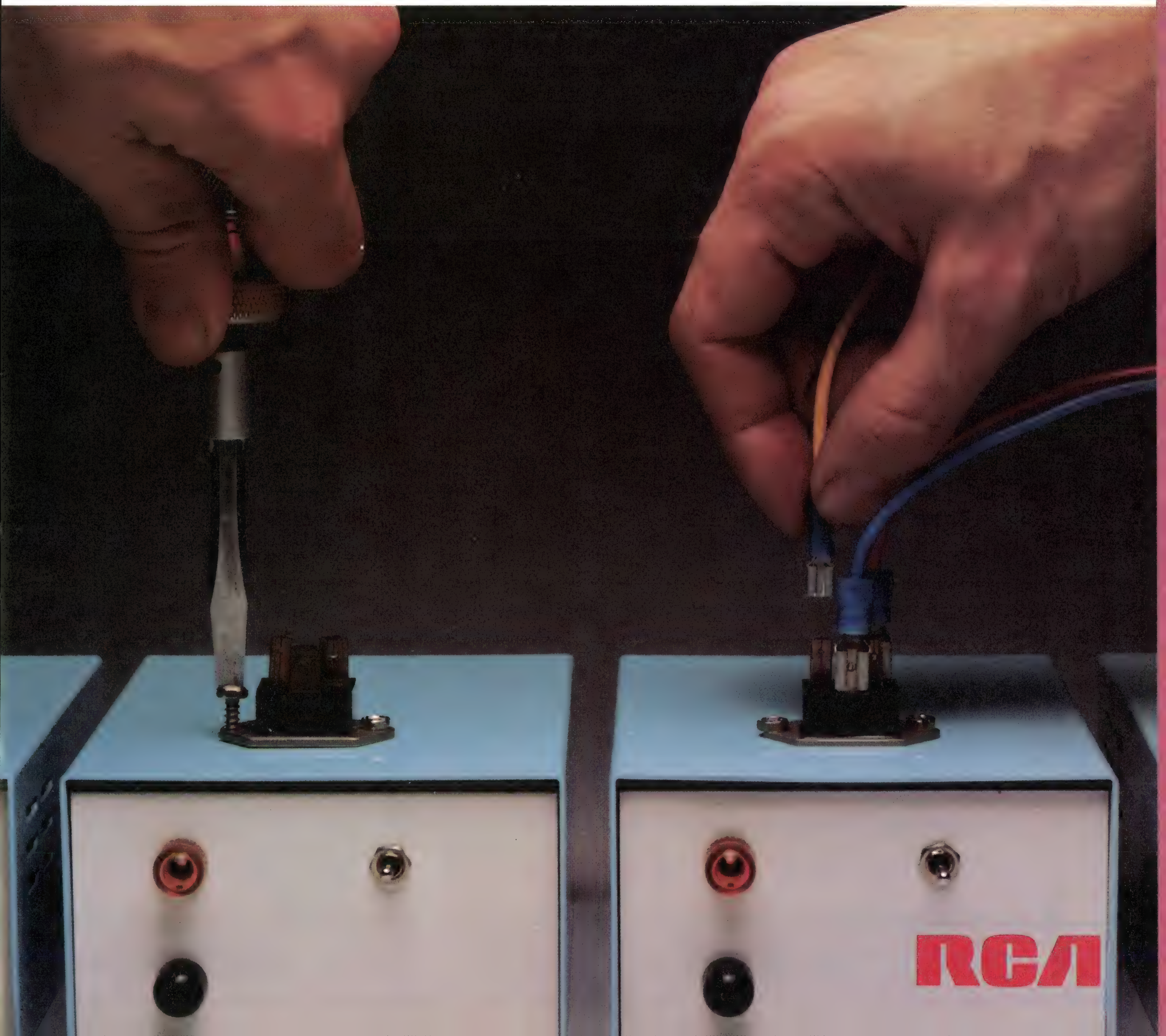
We've kept the price down too, by using a glass passivated chip in a molded plastic package. And there's no loss of reliability compared to the standard stud package.

You can use the RCA QuikOn triac to control AC loads in large appliances and other types of high current equipment.

For more information, contact your local RCA Solid State Distributor.

Or RCA Solid State headquarters in Somerville, N.J. Brussels, Belgium. Tokyo, Japan.

CIRCLE NUMBER 63



Choose TI's 16-bit 9900 Family. For price. For performance. And because it's production-proven. You'll be in the best of companies.

By the hundreds, companies are staking new product designs on TI's 9900 Family. A wide diversity of products. By companies large and established. By those small and growing. The brief recap on the opposite page lists just a few of the many innovators who have seen the future and chosen the 9900 Family. For a lot of good reasons:

Here-and-now compatible family

Unlike others who plan or promise, the 9900 Family is a fact. Available from your TI distributor today. Microprocessors. Peripherals. Microcomputer modules. Development tools. All compatible to protect your software investment as you move from one product design to another.

From the beginning, TI has been the 16-bit leader. The 9900 Family has grown. Matured. Become second sourced.

We'd like to say it's complete. But that will never be. TI is firmly committed to the Family's expansion according to your needs and as new technologies develop.

Price/performance microprocessor choices

Utilizing the most advanced architecture on the market today, the microprocessors in the Family include the original NMOS TMS9900. The functional I^2L equivalent, the SBP9900A, for harsh environments. The lower-cost TMS9980/9981 versions for smaller systems.

Now coming into production: TMS9940, the industry's first 16-bit single-chip microcomputer with on-chip memory and I/O.

In total, an unequalled choice that lets you more easily and quickly match price and performance to your designs.

Low-priced peripherals

At last count, 14 peripherals support these microprocessors. The LSI "nuts and bolts" needed to complete your system. Easily. Economically.

For memory expansion to 16 megabytes there's the new TIM99610 Memory Mapper.

To fill your communication needs: TMS9902 Asynchronous Controller, TMS9903 Synchronous Controller, TMS9911 DMA Controller, and the new TMS9914 GPIB Adapter.

Also of interest: The TMS9927 CRT Controller and the new color graphics TMS9918 Video Display Processor.

Cost-conscious microcomputer modules and minicomputers

For a headstart in systems design, look into the Family's series of 16-bit TM990 microcomputer modules for evaluation, systems prototyping, and OEM applications.

The TM990 series includes standalone CPUs, memory expansion, and I/O expansion modules. And modules for program development. For learning and teaching.

TI's compatible 990 minicomputers extend the 9900 Family's level of integration to packaged host systems for distributed processing and a wide variety of other applications.

End products:

Where the 9900 Family is shining.

Every day, the 9900 Family is proving itself where it counts. In the marketplace. At the core of new products, new designs.

Many major companies, whose large resources and staffs allow them to weigh carefully all considerations and options, have elected to build products around the 9900 Family. Among them are Litton Aero Products, Allen-Bradley, Tektronix, Veeder-Root, Sweda International, John Fluke, Amoco, E.I. DuPont, Sun Electronics, General Electric, Otis Elevator.

Also, a large number of young, aggressive companies have selected the 9900 Family . . . companies who cannot afford failure. Among them are Acuity Systems, Optronics Ltd., Harowe Systems, Micor, Cubic, Praxis Ltd., Nicolet, Delta Data.

Texas Instruments, where the bottom line is as important as anywhere else, uses the 9900 Family as the heart of its pacesetting home computer. In its Loran-C receiver. In minicomputers and terminals. In satellite navigation systems. In aircraft tracking and collision avoidance support systems.

The proof is convincing. For performance, economy, versatility, support, your first choice in 16-bits is the 9900 Family. You'll be in the best of companies.

Here-and-now Pascal

Just as many are playing catch up in 16-bit microprocessors, they're working overtime on high-level languages. Particularly Pascal. But TI has had operative Pascal for several years. Long enough to refine it for microprocessor applications.

TI's new Microprocessor Pascal offers the most extensive support available: Editor, compiler, host debugger, configurator, native-code generator, and run-time support.

Also: Compilers for Fortran and interpreters for Power Basic — all available on the Texas Instruments floppy-based AMPL* development system.

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CIRCLE NUMBER 26

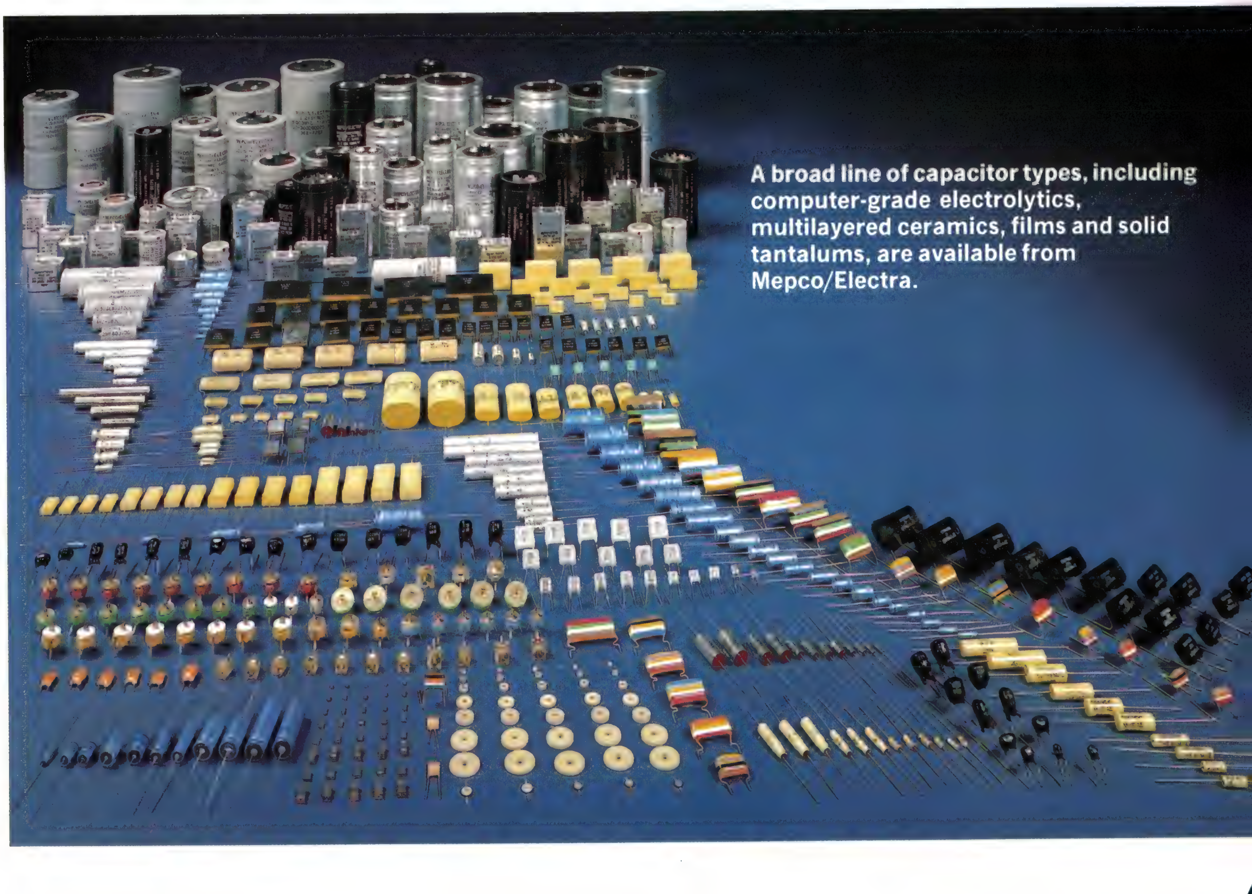
Focus on capacitors: Performance charges with improved dielectrics in small packages

Responding to the general thrust of advanced electronic technology—better performance in smaller packages at lower cost—capacitor manufacturers are producing greater capacitance and stronger stability in smaller tubes. Spurred in particular by shortages of certain materials and by the demands of high-volume equipment manufacturers, they are refining other dielectric and packaging materials, while unveiling a series of new packaging configurations:

- Among capacitor dielectrics, multilayered ceramics are the fastest growing as they carve out new application areas and effectively shrink in size while offering higher capacitance values and improved stability.
- Aluminum electrolytics are battling with tantalums over size, price and performance specs. Improved etching processes are increasing the capacitance and decreasing the size of aluminum anodes and cathodes.
- Tantalum, though shooting upward in cost, is still being used in many high-rel application areas—it is extremely difficult to surpass in terms of size-cost-performance.
- Alternatives to tantalum such as polyester and other plastic compounds are getting renewed attention as dielectric materials in metalized film capacitors. Film capacitors offer extremely tight tolerances and excellent stability.
- Automatic insertion equipment continues to dictate some capacitor packaging options. The increased availability of insertion equipment for radial-leaded devices will effectively increase the popularity of low-cost dip-coated components. Insertion equipment, moreover, having spurred the introduction of ceramic capacitors in miniature DIP packages, will also affect the design of many new chip components.

Among the available capacitor types, multilayered ceramics have proved the most versatile for high-

Stephan Ohr
Components Editor



A broad line of capacitor types, including computer-grade electrolytics, multilayered ceramics, films and solid tantalums, are available from Mepco/Electra.

frequency applications requiring small size and low cost. Not only are they encroaching on the territory claimed by mica, paper and other types of capacitors, they are even replacing tight-spec'd tantalum chips in some application areas. There isn't a capacitor manufacturer who isn't involved with multilayered ceramics, though manufacturers like AVX, Centralab, Erie and Murata provide ceramics exclusively.

Unlike other dielectrics, especially tantalum, whose operating impedance tends to increase with frequency, the internal inductance of multilayered ceramics is small. As a result, the operating impedance of ceramics remains stable through much of the frequency range, and actually decreases above 1 MHz. Indeed, though the actual impedance drop depends on the capacitance value and the temperature-stability characteristic, the majority of ceramics shows better impedance characteristics above 1 MHz than many other dielectrics.

A 1000-pF NPO ceramic, for example, exhibits an impedance drop in the vicinity of 40 to 70 MHz. A 0.01-μF X7R ceramic, in contrast, has an impedance drop in the 10 to 40-MHz region, while a 0.1-μF Z5U drops in range from 1.4 to 23 MHz. This sort of impedance drop turns the capacitor into a short circuit in these frequency ranges, though it will easily block or filter current flow at every other frequency.

For these reasons, unpackaged ceramic chips, like those by Vitramon and JFD, are widely used in hybrid rf amplifiers and other microwave applications, while leaded ceramic devices are increasingly used to couple and filter memory devices in high-speed logic circuits.

As it turns out, benefit begets benefit. The large volume of ceramic capacitors used for this one application area has fostered an increasingly popular packaging concept: the two-pin, low-profile, miniature-DIP package. Since ceramic capacitors are frequently the only passive components to share space with DIP-packaged microprocessors and memory devices on a computer PC board, the two-pin DIP ceramic with 0.300-in. centers and 0.175-in. profiles will allow automatic insertion equipment to put down both the semiconductors and the capacitors in a single operation, while taking up a minimum of board space.

Notable components available in the mini-DIP configuration include AVX's DIP Guard, Centralab's Mono-Pak, ITW Emcon's Empac Spacesaver, Sprague's mini-DIP and Union Carbide's Kemet Mighty Max. All come on 0.300-in. pin spacings with 0.175 or 0.165-in. profiles off the board. Capacitance values for the majority of the DIP-packaged ceramics are below 220,000 pF, while the breakdown voltage seldom exceeds 100 V. NPO and X7R temperature-stability characteristics are available, though Z5U tends to be common in the higher capacitance ranges.

Glass-coated ceramics like these Centralab Mono-Glass caps come on taped reels for automatic insertion.

Size, stability trade-offs

Reducing the size of ceramic capacitors or any capacitor also results in some negative tendencies. With the dielectric itself becoming thinner and covering less area, available capacitance and breakdown voltage tend to shrink. Ultrathin, small capacitor dielectrics tend to bend and stretch.

On the other hand, the temperature stability of multilayered ceramics tends to vary with the area of the dielectric layers—the broader the area covered by the dielectric (the greater the capacitance), the more likely it will bend, warp, or leak with changes in temperature or humidity.

The dielectric material here is a coarse, grainy ceramic mixture, which is extruded and baked before metalization. In very small thicknesses, the granular structure offers less resistance to overvoltage breakdowns than other dielectrics. The granular structure, moreover, has its own tendency to absorb moisture easily, paving the way for leakage and other changes of value.

As a result, the most stable capacitors are the most limited in capacitance value. The NPO temperature characteristic, for example, which allows almost no change in capacitance value, −30 ppm/°C, over the entire range from −55 to +125 C, is usually limited in capacitance value, with 27,000 pF the typical maximum for an NPO ceramic. Other popular temperature-stability characteristics include the reasonably stable X7R, which allows a ±15% total capacitance change over −55 to +125 C, and the Z5U, which permits gross changes in capacitance with temperature: +22% to −56% in the relatively narrow range from −10 to +85 C. However, in addition to its low cost for consumer electronics applications, such as home entertainment devices (where the ambient temperature seldom varies from 20 or 25 C), the Z5U provides the highest capacitance available in a microminiature ceramic—approximately 1.5 μF.

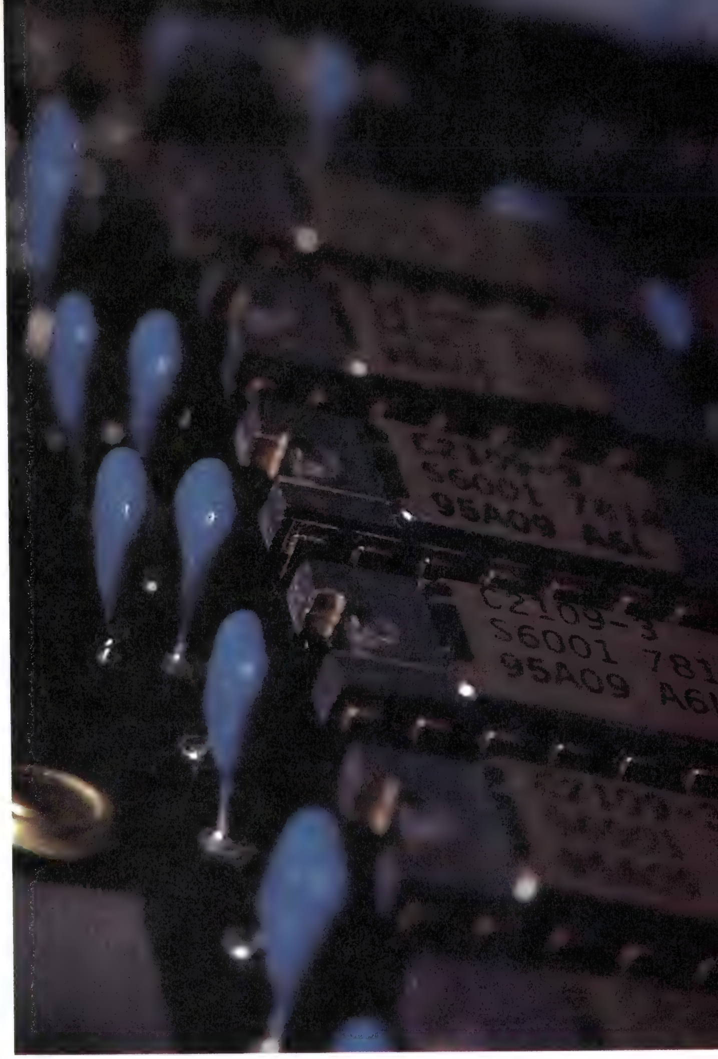
Barium-titanate and strontium-titanate dielectrics have greatly improved the stability of miniature and microminiature ceramics. The GPC 6000-series tubular ceramics from Mepco/Electra, for example, provide up to 33,000 pF in a package smaller than a 1/4-W resistor. Nicknamed "Super K," they are available with a Y5P temperature-stability characteristic (±10% total capacitance change from −30 to +85 C) in capacitance values where the less stable Z5U would ordinarily prevail. They are also available with COH temperature-stability characteristics, notably less than ±60-ppm/°C total change from −55 to +125 C. Capacitance values for these Class I capacitors in the GPC 6000 series range from 1 to 180 pF, with tolerances of ±5% and ±10%. Standard breakdown voltages are 16, 25 and 50 V.

COH and COG capacitors, as a result, are now being used not only in the small places once reserved for X7R and Z5U types, but also in application areas once reserved for mica and tantalum-oxide dielectrics. Dip-coated, radial-leaded ceramics, in fact, are now being offered by several manufacturers as replacements for dip-coated mica capacitors. AVX's NPO Skycap series, for example, will provide ±0.5% purchase tolerances for values above 100 pF. Breakdown voltages are 300 and 500 V, while the NPO stability is easily ±30 ppm/°C—a far cry from the ±200 ppm/°C for many of the best mica capacitors. Most significant, while the lead spacing of both the dip-coated ceramic and the equivalent dip-coated mica remain the same, the body size of the ceramic is approximately 20 to 30% smaller in profile.

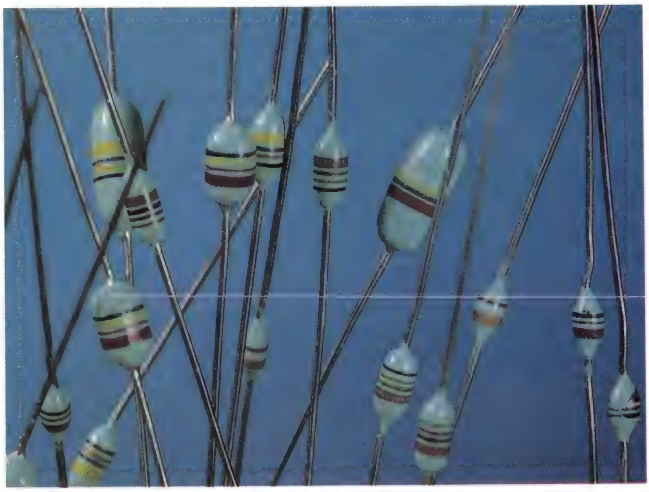
Not only are ceramics replacing silver micas in certain high-frequency applications, they are also making significant inroads on tantalum-oxide capacitors. Independent research conducted by ceramics manufacturers such as Centralab and AVX indicates that at certain frequencies, multilayered ceramics can satisfactorily replace tantalum capacitors by matching not capacitance value but performance factors like impedance and dissipation.

Centralab, for one, has found that a ceramic capacitor working at 10 kHz need only have 30% of the capacitance value of an equivalent dip-coated tantalum electrolytic. Indeed, above 1 MHz, the capacitance value need only be 1 or 2% that of tantalum. AVX is more conservative, with data suggesting that the ratio of tantalum capacitance to ceramic capacitance should be 10:1 for equivalent performance at high frequencies.

Multilayered ceramics, however, are not the only dielectric materials currently approaching tantalum-



Skycaps from AVX, as well as other dip-coated, multilayered ceramics, effectively replace mica capacitors in high-speed μP applications.



Packaging options available for Murata ceramics include axial-leaded devices with conformal coatings.

style performance. With tantalum, an African-mined material, becoming harder to obtain and thus more expensive, more and more miniature aluminum electrolytics are appearing as possible alternatives. A large number of these are available from Japan and Europe, but there are a number of American manufacturers with competitive offerings.

Aluminum strikes back

A good example of the type of aluminum capacitors being offered as "almost as good" tantalum replacements is the K series from Panasonic. Radial-leaded, these electrolytics—some no bigger than a pencil eraser—are intended to fit in the tight board spaces once exclusively reserved for dipped tantalums. Available capacitance values range from 0.1 to 100 μF, with dc working voltages from 6.3 to 63.

The longest K-series capacitor is less than 0.28 in. and the longest diameters are less than 0.248 in. For these reasons, they are aimed where size and low cost are primary concerns—consumer-electronics applications such as automotive controls, home-entertainment consoles, recorders and calculators.

Other manufacturers whose miniature electrolytics provide possible alternatives to tantalum include Nichicon America, whose advanced etching of the aluminum anode produces a miniature electrolytic with unusually low leakage—at most, 0.002 CV or 0.4 μA, from −40 to +85 C. The LL series is available in capacitance values from 0.1 to 100 μF, with both axial or radial leads. According to Nichicon, its aluminum devices will cost up to 40% less than similarly-sized tantalums. Its CEO4W radial-leaded capacitors are available with capacitance values from 0.47 to 3300 μF and dc working voltages up to 450; and its CEO2W axial-leaded capacitors offer capacitance values up to 6800 μF.

"Smaller than the equivalent dip-coated tantalum" aptly describes miniature aluminum electrolytics like this K-series unit from Panasonic.

Siemens provides miniature aluminum electrolytics with either axial or radial leads in the B41313, B41283 and B41010 series. The axial-leaded capacitors provide up to 10,000 μF (6.3 V dc) in a 1.594-in.-long × 0.807-in.-diameter package. The smallest radial-leaded devices are 0.472 in. long with 0.216-in. diameters and have capacitance values ranging up to 22 μF at 6.3 V.

Domestic sources for the radial-leaded devices are headed by Sprague, whose 502D and 503D Verti-lytic miniatures provide capacitance from 0.47 to 3300 μF in packages as small as 0.433 in. long and 0.236 in. in diameter. In addition, welded interconnections ensure excellent surge protection. Mepco/Electra's 3070-series axial-leaded capacitors are available with 0.177-in. diameters and 0.433-in. lengths and offer low ESR, high ripple-current capacity and low dc leakage currents.

While the miniature aluminum electrolytics are competitive with dipped tantalum in size and price, the tantalums are still more reliable in general. While dc leakage currents for the Panasonic K-series electrolytics, for example, are specified at 3 μA max, dc leakage current for an equivalent dip-coated tantalum is only 0.05 μA. In addition, the dissipation factor for aluminum electrolytics varies from 0.08 to 0.24 at 120 Hz, but only 0.04 to 0.10 for tantalums. Similarly, load life, rated for miniature aluminum electrolytics at 1000 hours at 85 C, is rated at 2000 hours for dipped tantalum at the same temperature.

Aluminum solids

What's more, while miniature aluminum electrolytic capacitors are approaching tantalum in certain small-size, low-cost application areas such as consumer electronics, their leakage currents and dissipation factors are still greater. Nevertheless, a class of aluminum capacitors will approach tantalum performance in small capacitance values. Aluminum solids, intended for use in bypass coupling and filter circuits, provide an unusually low leakage current in the vicinity of 0.5 to 1 μA. The dissipation factor at 120 Hz is typically between 0.08 and 0.12 in a −55 to +85-C operating range.

The Aloxcon SR 20 series from Fujitsu America, for example, provides small leakage currents and dissipation factors in a package as small as 0.394 in. long, with 0.197-in. diameters. Capacitance values span 0.068 to 10 μF, voltage ratings from 6.3 to 35 V dc.

The Aloxcon LL20 series provides 0.1 to 4.7 μF in a similarly sized package, with leakage currents even less than 0.5 μA and dissipation factors less than 0.08. They are intended for switching power supplies and other medium-frequency bypass coupling and filter applications.

Solid and wet-slug tantalums as well as computer-grade aluminum are among the offerings from Mallory.

A variety of tubular electrolytics is available from Siemens, including aluminum, tantalum, and foil-film.

For high-frequency applications, the Aloxcon HF 10 series provides less than 0.1-μA leakage currents, a small ESR of less than 0.5 Ω at 10 MHz, and a dissipation factor in the vicinity of 0.025 max at 1 kHz. The capacitance range is small—0.047 to 0.47 μF.

Champion tantalum

Low-cost and special alternatives aside, there is actually nothing to replace tantalum-oxide dielectrics in terms of high performance in a small package. Although ceramics allow a higher dielectric constant than tantalum oxides, they are susceptible to temperature and humidity. Tantalum oxides, on the other hand, retain their stability even under a wide variety of environmental conditions.

Even aluminum solids offered as a capacitance-voltage substitute cannot match tantalum performance. The high-performance end of Fujitsu's solid-electrolytic line, for example, is shared by aluminum-solid and tantalum-solid capacitors. Both types are recommended for bypass and filtering applications for high-speed logic in microprocessor circuitry. But while the aluminum-solid R53 and R56 series are recommended for high-speed pulse filtering (TTL), the tantalum-solid R58 series provides good performance for ultrahigh-speed logic such as ECL.

The R53 and R56 provide a capacitance of 1 μF at 25 V in a rectangular package 7.0 mm long, 5.08 mm wide and 6.35 mm high. The dissipation factor at 120 Hz is less than 12%, leakage currents are less than 3 μA, and the ESR is less than 1.5 Ω.

In the same-sized package, the R58 Tantalcon series, provides up to 4.7 μF (6.3 V), less than 1 μA of leakage current, less than 10% dissipation factor, and less than 0.5-Ω ESR. Consequently, tantalum capacitors are among the popular product offerings from Corning, Union Carbide, Mallory, Sprague, Siemens and Mepco/Electra.

Miniature tantalums from Sprague, for example, include the 162D Red Tops, whose sizes range from 0.260 in. long with 0.095-in. diameter (8.2 μF at 2 V dc) to 0.420 in. long with 0.180-in. diameter (4.7 μF at 50 V dc). All have axial leads for automatic-insertion equipment. Another axial-leaded product, the 173D Tantalex, is a bullet-nosed, molded-epoxy capacitor with values from 0.1 to 56 μF in voltage ranges from 6 to 50 V dc.

Another Sprague offering features a packaging configuration destined for greater popularity. The 193D Domino solid-tantalum capacitor is essentially an epoxy-coated chip with solderable metal tabs at each end. Case sizes vary from 0.180 in. long, 0.090 in. wide and 0.070 in. high to 0.320 in. long, 0.180 in. wide and 0.195 in. high. Capacitance values range from 0.1 to 10 μF at 35 V dc. The major factor for the popularity will be insertion equipment for discrete chip components, which is appearing more and more at electronics packaging exhibitions.

Another chip configuration is featured in the Series 4000 Blue Chip tantalum capacitors from Mepco/Electra, which feature solderable end caps. For applications where small space is required, such as heart pacers, the tantalum chips come with ±5%, ±10%, and ±20% tolerances. Capacitance values from 0.1 to 100 μF are available with 4 to 50-V ratings. In addition, they are qualified according to MIL-C-55365, Style CWR06, for "R" failure rates—that means less than 0.01% per 1000 hours of use.

Mepco/Electra also provides epoxy-dipped and molded solid tantalums with radial leads and tolerances down to ±5%. Capacitance values from 0.1 to 330 μF are available with working voltages from 6 to 50 V dc.

Solid tantalums with established reliability are also available from Sprague and Mallory. Sprague's CSR13 solid tantalums are glass-to-metal sealed and available in ±20% and ±10% tolerances with L, M, P, R and S failure rates. Capacitance values range from 0.0047 to 1000 μF in working voltages from 6 to 100 V dc. Mallory's solid tantalum types, TER, TXE, TXRm and TNR, are qualified according to the requirements of MIL-C-39003, as well as MIL-C-39006 for M, P, and R life-failure rates.

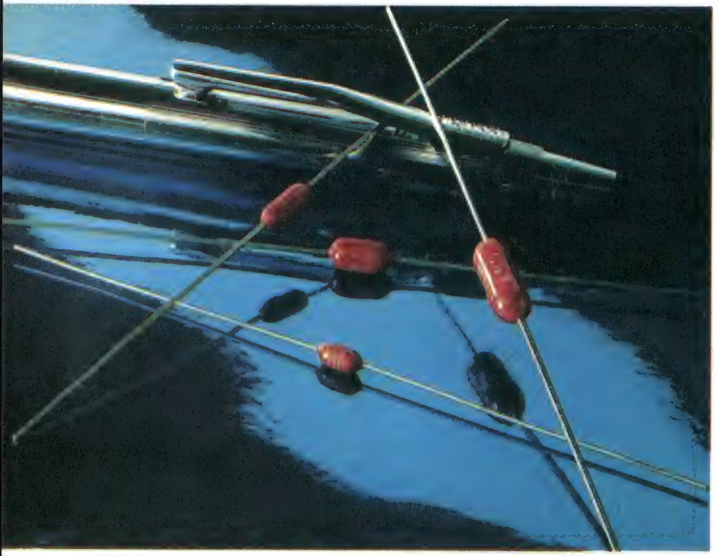
Computer grades

While aluminum electrolytics can only approach the tantalum performance in small sizes, they stand alone in power-supply filters. That means large capacitance values and sizes.

These filters operate at low and medium frequencies to filter the ripple currents out of dc power supplies. In addition to extremely high capacitance values, computer-grade electrolytics must withstand possibly high overvoltage surges and strong ripple currents while providing very small ESRs.

Computer-grade electrolytics from Mallory, for example, can provide capacitance up to 100,000 μF in a single can while withstanding ripple currents up to 26.70 A at 120 Hz—and ESR is less than 0.010 Ω. Overvoltage surge protection is roughly 25% better than the working voltage, which means that a computer-grade electrolytic with a voltage rating of 100 V dc is protected from surges up to 125 V dc; a 450-V dc capacitor is protected from surges up to 525-V dc.

High-performance computer grades, in addition, provide extremely high capacitance values and ripple-current capability for such demanding applications as computer mainframes, X-ray and medical equipment, telecommunications and broadcast equipment, and industrial controls. The high-performance CGR from Mallory is available with capacitances up to 320,000 μF and ripple-current capability up to 35.9 A at 20 kHz and 85 C. Thirty-six case sizes are available—with lengths and diameters ranging from 1.750 in. and 1.375 in. to 5.625 in. and 3.00 in.—all with screw-type terminals.



Axial-leaded ceramics like these Spinseal capacitors from Corning are available with X7R and COG temperature-stability characteristics.

For switching power supplies, these tubular aluminum electrolytics from Sprague offer welded leads, low ESR and high ripple-current capacity.

Screw terminals, radial leads and axial leads are all available on Mepco/Electra's 3120, 3191, 3428 and 3050, all of which provide unusually good operating life—up to 2000 hours at 85 C. ESR is less than 0.0023 Ω at 120 Hz, 125 C for 240,000-μF types at 6 V dc. Total capacitance-value range stretches from 220 μF to 1 F.

The film advantage

Solid-tantalum capacitors also end up on the short side of tolerance—normally on the order of ±5%. Film capacitors, however, can sport 2.5% and ±1% or better. Precision film capacitors from PFC, for example, are available with ±0.25% and ±0.1% tolerances. PFC, in fact, manufactures a calibration standard that is accurate to ±0.05, with a linear temperature coefficient of ±5 ppm/°C from −55 to +85 C.

For dielectrics, PFC uses polystyrene and polypropylene. Polyester is currently among the most popular film dielectrics, while polycarbonate and polysulfone are growing in use.

In addition to tight capacitive tolerances, film-capacitor dielectrics offer dielectric strength great enough to produce high breakdown voltages in relatively small packages and good temperature stability. "Self-healing" is often another attribute. Should an overvoltage break through the dielectric layer, the metalized area in the vicinity of the breakthrough evaporates, without harming the dielectric, in about 10 μs. As a result, an overvoltage breakdown will not short-out the capacitor plates.

Among the film-capacitor dielectrics, polyester is the least expensive and therefore one of the most popular. Typical polyester capacitance ranges from 0.001 to 6.8 μF, with tolerances in the vicinity of 2.5%.

Working voltages range from 100 to 630 V dc, 63 to 220 V ac. Dissipation is on the order of 0.8% at 1 kHz and 25 C. Operating temperatures range from −40 to +100 C with temperature coefficients better than 400 ppm/°C.

Typically used for rf filtering applications, polyester dielectrics can provide high capacitance in a relatively small package having radial or axial leads. A 6.8-μF, 400-V metalized polyester stacked film capacitor from Siemens, for example, measures 0.985 in. long, 0.768 in. high and 0.512 in. thick.

Polystyrene capacitors provide lower capacitance values but with much tighter tolerances. Siecor's offerings range in capacitance from 47 to 100,000 pF in working voltages from 25 to 630 V dc, but with tolerances to ±1%. Dissipation factor is better than 0.05% at 10 kHz. Operating temperature range is −10 to +70 C, while the temperature coefficient is better than −150 (±50) ppm/°C. Sprague and Mallory also offer polystyrene capacitors.

Polypropylene, while superior to polystyrene as a dielectric, costs more. Here, 0.01 to 10-μF capacitances, 1% tolerances and −100 ppm/°C tempcos are standard. But in OEM quantities, the price range is also higher—7 to 13 cents vs 4 to 7 cents for polystyrene (and 6 cents for rolled polyester).

Dissipation factor for polypropylene is 0.1% at 1 kHz, and dimensions are small. Axial-leaded polypropylene capacitors from ITW Paktron, for example, are typically less than 1/2 in. long and 1/4 in. in diameter in the 200-V range.

Such strong dielectric properties have allowed TRW Capacitors Div. to formulate a metalized capacitor for high-current and high-frequency applications such as switching power supplies. The TRW-35 provides capacitance values up to 30 μF at 100 V dc, with an ESR less than 8 and a current-handling capacity better than 9 A. Dissipation factor is better than 0.1% at 1 kHz. Polyester and polycarbonate are also in the TRW film-capacitor line.

Aluminum electrolytics, ceramic disks and polyester films are all available from Nichicon.

Polycarbonate-film capacitors approach polystyrene performance but in a smaller size. A 1.0-μF, 200-V metalized polycarbonate, for example, is 1.0 in. long with a 0.531-in. diameter. A polypropylene with the same values would be 1-1/4 in. long with a 0.516-in. diameter. And the polycarbonate performance is impressive: 0.4% dissipation at 1 kHz, and 150-ppm/°C tempco from −40 to +85 C.

Until recently, polysulfone was not generally available for use as a capacitor dielectric. Polysulfone capacitors introduced by Sprague, however, boast excellent stability up to 125 C.■■

Need more information?

For further information on capacitors, readers may consult the manufacturers that cooperated in the preparation of this report by circling the appropriate numbers on the reader service card. But all the manufacturers don't make every type of capacitor. More information on specific vendor lines may be found in appropriate categories in ELECTRONIC DESIGN'S GOLD BOOK.

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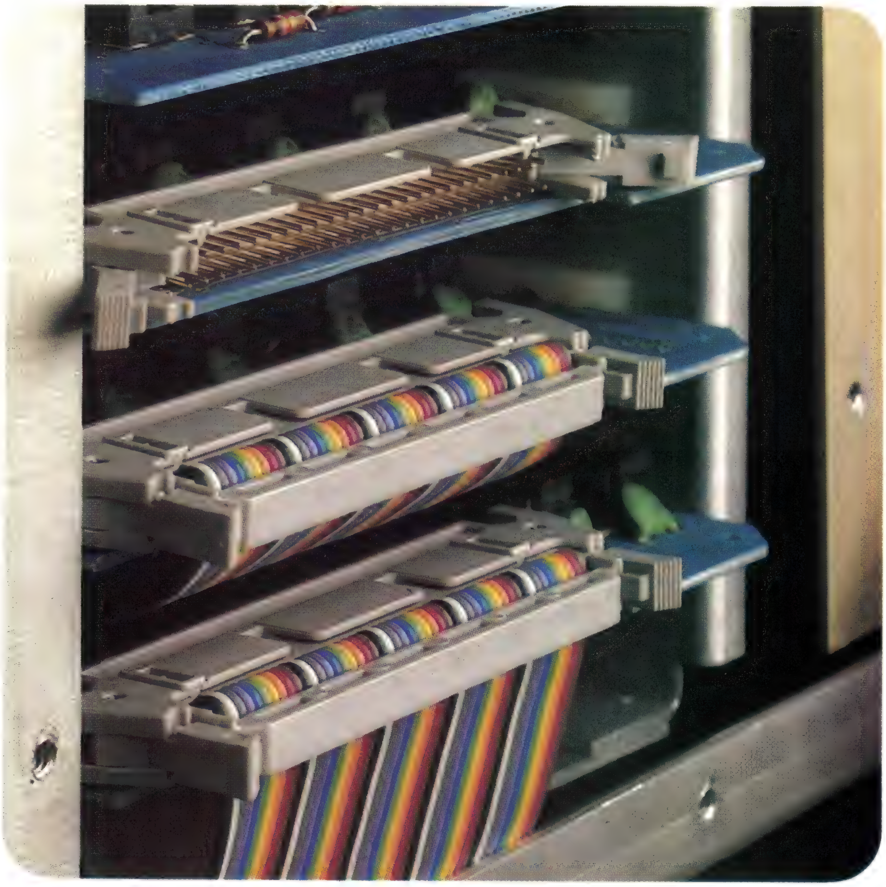
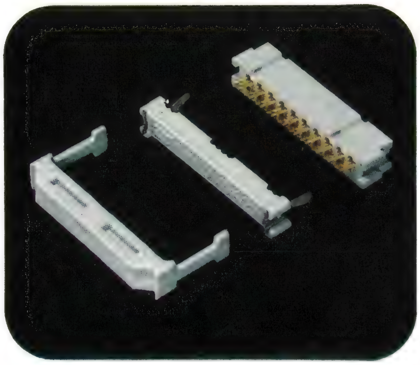
Now from 3M come several important design changes in Scotchflex brand socket connectors and headers. Changes aimed at bringing you faster assembly, increased reliability and reduced maintenance.

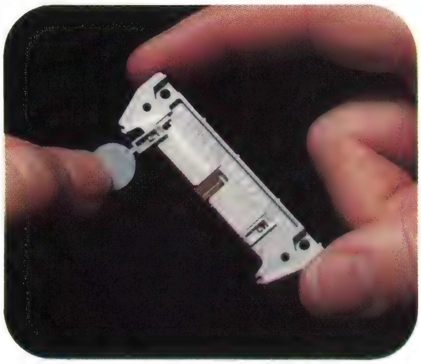


Scotchflex headers (.100″ x .100″ grid series) now include built-in retainer/ejector latches that snap up to lock sockets firmly in place and snap down to disconnect them quickly and easily. Latches hold tightly against vibration and shock, and their ejector feature also helps reduce wear and damage from disconnection and reconnection. They work with or without strain relief clips on both new and previous .100″ x .100″ Scotchflex socket designs.

and a snap to unplug.

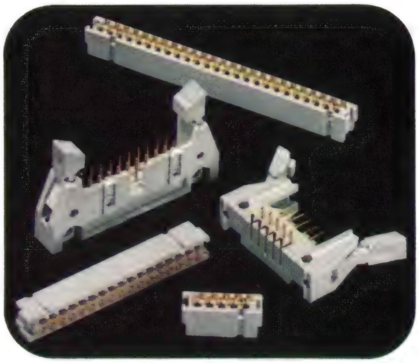


Mating socket connectors have been redesigned with metal spring clips that lock cover to body tightly, providing greatly increased cover retention. And a new one-piece strain relief clip now reduces parts inventory and cuts assembly labor time.



An improved keying system permits positive polarization without pin loss, helps reduce equipment damage and field maintenance. Connectors snap into polarized headers to insure positive mating and provide increased retention.

New socket and header sizes have been added, too. Scotchflex sockets and headers with .100″ x .100″ grid spacing are now available in 10, 14, 16, 20, 26, 34, 40, 50 and 60-pin sizes to suit your design needs.



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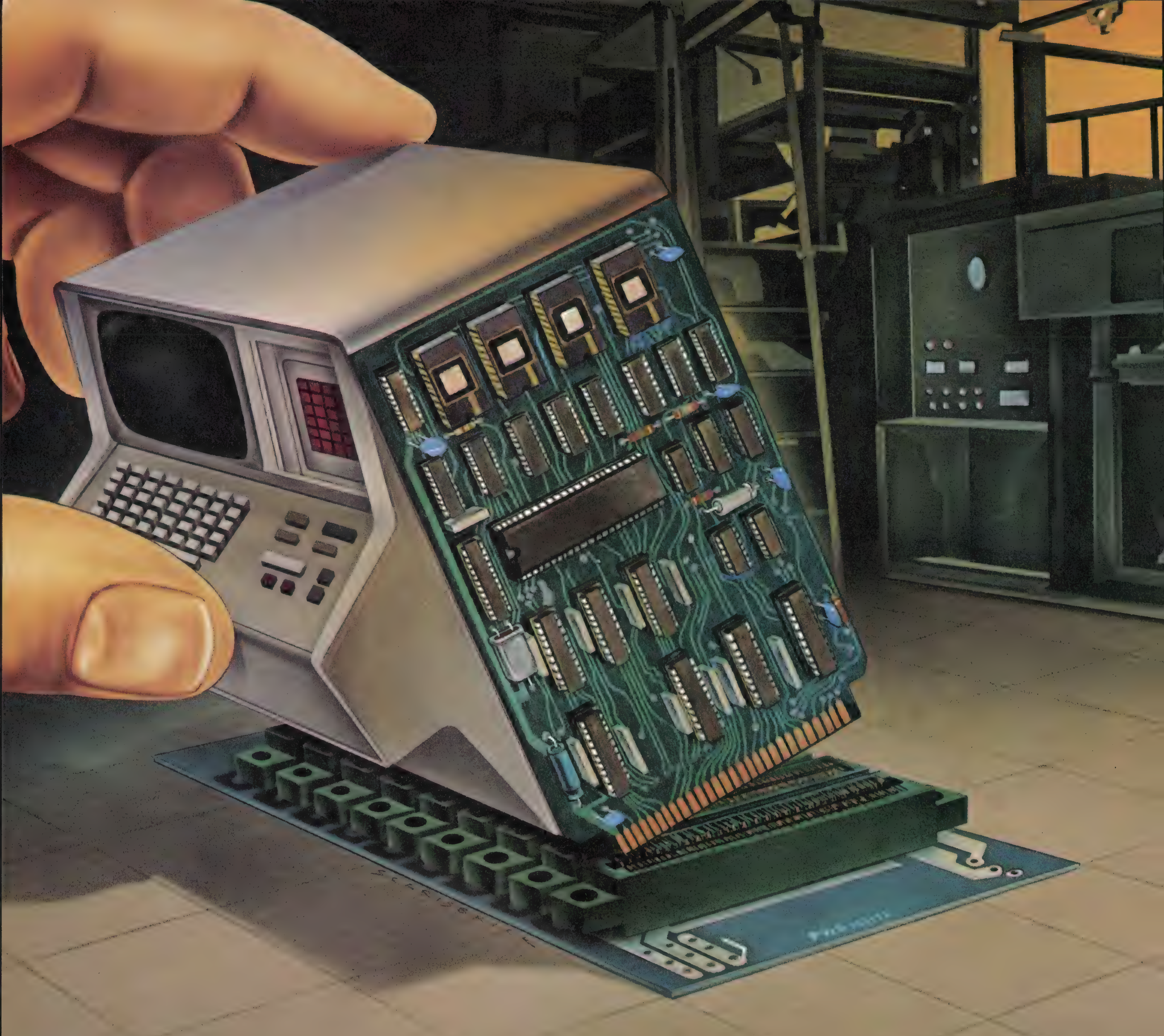
CIRCLE NUMBER 67



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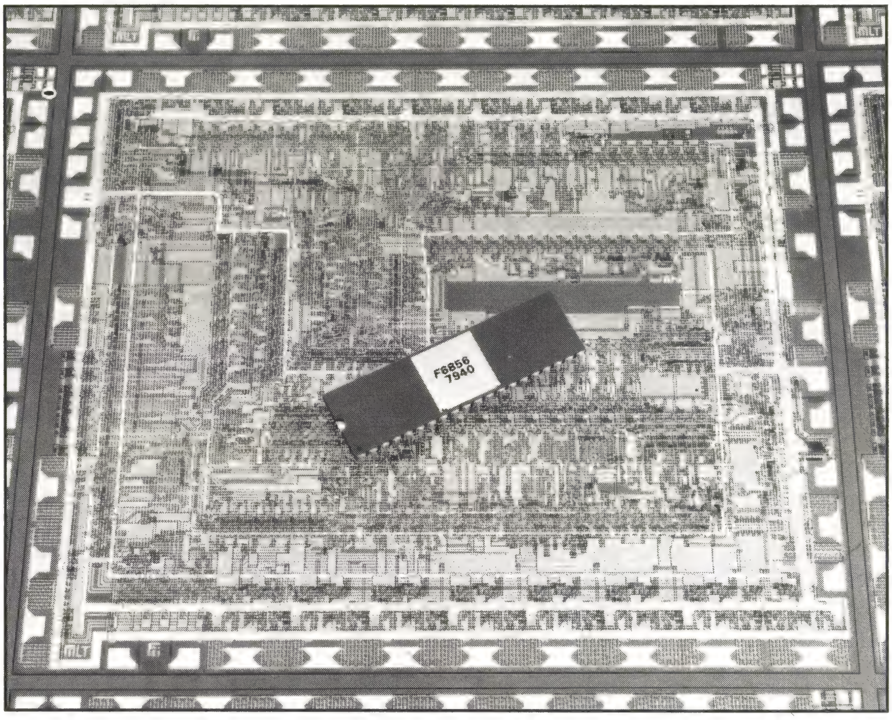
CIRCLE NUMBER 68

Controller handles synchronous protocols with very little CPU help



Fairchild MOS Products Group, 101 Bernal Rd., San Jose, CA 95119. (408) 224-7106. P&A: See text.

The NMOS F6856 from Fairchild MOS Products Group could well be the most versatile and autonomous single-chip controller for synchronous communications-line protocols. The Synchronous Protocol Communications Controller supports full-duplex transmission by converting parallel data from 8 to 16-bit CPU buses to a serial bit stream for transmission while reconverting received bit-serial data to 8 or 16-bit parallel bus format. What's more, with minimal CPU help, messages conforming to any of eight selectable synchronous line protocols may be processed.

The line protocols are categorized as either bit-oriented protocols (BOPs) or byte or character-controlled protocols (BCPs). All the CPU has to do is load eight bits of transmitter-control information into half the controller's transmitter-control/data register (TCDR) as well as eight bits of receiver-control information into half the receiver-control/transmitter status (RCTS) register. The controller handles the rest.

Three bits in the controller's mode-control-sync/address register (MCSA) determine the operative protocol. These include a primary, secondary or secondary-global BOP, a general BOP, a DDCMP BOP and two versions of the widespread Bisync BCP—one using USASCII code, the other using EBCDIC code. BOPs such as SDLC, HDLC and its near twin ADCCP can be accommodated. With two other 3-bit combinations, a user can program other protocol selections.

Once the protocol is programmed in, by itself the controller:

- Converts line-transmission coding, like NRZI, to NRZ computer code.
- Monitors the serial bit stream and characters for designators and delimiters such as SYN, FLAG and ABORT.
- Inserts and deletes the bits and characters required by the programmed protocol.
- Generates an interrupt to the processor after completing a message either normally or abnormally (in an overrun or underrun condition).
- Generates the popular versions of cyclic-redundancy characters for transmission and performs the CRC checking on received messages. CRC options include CCITT, CRC-16, CRC-14, CRC-12 and CRC-10 versions.

For BOPs, the controller detects and generates special flag, abort and go-ahead control sequences. It also inserts and deletes ZEROs, allows selection of primary or secondary stations, and provides global and automatic extended addressing. One or two control bytes and data-character lengths of 5 to 8 bits with a 1 to 8-bit residual last character can be programmed.

For Bisync, the controller generates special DLE and SYNC characters, and detects the special DLE, SYNC, SOH, STX, ITB, ETB and ETX characters. It provides for 8-bit characters, inserts and selectively strips fill characters.

For BCPs like DDCMP, the controller provides programmable-sync characters and 5 to 8-bit character lengths. As in Bisync, it handles fill characters.

Modem-handshaking capability is also squeezed into the 40-pin package, with several commonly used modem signals provided in false-high form: RTS, CTS, DTR, DSR and CD. The chip also provides its own self-diagnostic loop test by internally connecting the transmitter output to the receiver input. What's more, it features TTL compatibility and 1-Mbit/s data rate.

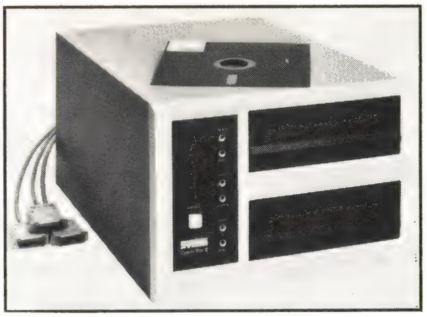
Currently in sampling, the F6856 is expected to be available in production quantities this month. In 100 to 999 qty, the plastic CIP version sells for $24.50 while a side-brazed ceramic version costs $29.90. **CIRCLE NO. 301**

Sidney Adlerstein
Communications Editor

Disk director automates transceiving on private-line communications network

Sykes Datatronics, 375 Orchard St., Rochester, NY 14606. (716) 458-8000. Appr. $500; 4 to 6 wks.

Communications-network stations can be made more productive and message dissemination more efficient with the 8A1/8B1 Message Station from Sykes Datatronics. An option for the Comm-Stor II and III communications stations, it adapts those units to the 8A1/8B1 private-line communications network and facilitates automatic transmission and reception of messages, even while an operator is preparing other messages.



Polled by a line controller, usually a mini or mainframe computer, the Message Station directs a floppy-disk unit to record or send data—all without operator intervention or interruption. Variable-length messages can be sent to one or more locations at any time convenient to the system. Up to 3000 messages of 128 characters each can be prepared and stored for future transmission, all at the direction of the network controller. Line speeds are up to 2400 baud.

The 8A1/8B1 protocol is designed for multipoint, private-line communications. In an 8A1/8B1 network, numersous terminals, often at remote locations, need to transfer data, one to another. The Message Station supports any asynchronous terminal or printer in the network.

Using the Message Station, Comm-Stor II and Comm-Stor III, previously limited to dial-line service, expand into 8A1/8B1 network use with the option. All features of the units are retained, including compatibility with most RS-232 terminals and printers. Comm-Stor III, with all the features of the Comm-Stor II, focuses on forms-data entry.

CIRCLE NO. 308

High-power varactors double/triple frequency

Microwave Associates, South Ave., Burlington, MA 01803. (617) 272-3000.

A series of multiplier varactor diodes, 1N Series, put out high power for frequency conversion use in the 150 MHz to 10-GHz range. Primarily for use in doublers and triplers, the devices can supply 25-W output for a 50-W input at 50 MHz. An input of 1 GHz and 12 W will be doubled for an output of 6 W. An input of 2.6 W at 5 GHz will yield an output of 1 W at 10 GHz. The devices come in a variety of case styles, including stud-mount.

CIRCLE NO. 390

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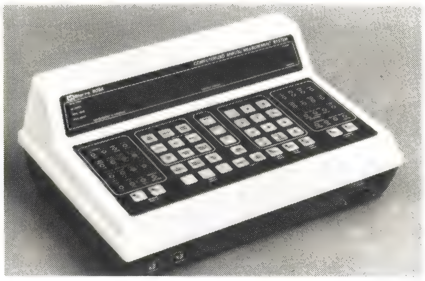
Analog measurement set tests telco data lines

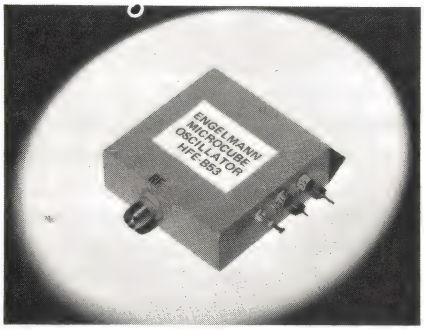


Lear Siegler Sierra Electronic, 3885 Bohannon Dr., Menlo Park, CA 94025. (415) 321-5374.

An analog measurement system, Model 809A, tests telephone lines in preparation for data traffic. All relevant analog parameters for data transmission are measured in accordance with BSTR 41009. Test parameters and test results for up to nine different measurements are stored in memory and can be recalled at any time—even when a line is disconnected. Remote control is provided through an IEEE-488 or RS232 bus.

CIRCLE NO. 321

2-GHz oscillator supplies spurious-free output



Engelmann Microwave, Skyline Dr., Montville, NJ 07045. (201) 334-5700. $325.

A fundamental transistor oscillator, Model HFE-B53, provides a spurious-free, 17 to 20-dBm output over a ±50 MHz tuning range centered at 2090 MHz. Spurious responses are less than 80 dBc, in or out of band. A wide range of input voltages are accepted—from 12 to 24 V dc. An internal regulated power supply minimizes pushing effects and provides overvoltage protection. A fine-resolution screwdriver tuning shaft or optional afc tuning is available. Free-running, long-term temperature stability is ±0.15% over a 0 to 50-C range. An optional low-pass filter keeps second harmonic content to no more than 25 dBc.

CIRCLE NO. 322

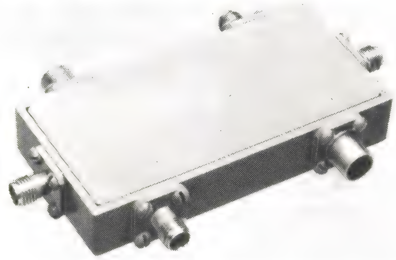
DES encryptor protects stored/transmitted data

SPI Data Systems, 488 Cowper St., Palo Alto, CA 94301. (415) 328-5183. $2390 (150); $2950 (250); 4 wks.

DataLock, a data encryption device following the NBS Data Encryption Standard, assures security of both communicated and stored data. Functions include encryption and decryption of data passing through a computer terminal, files stored in a computer and communications between two system users in a timesharing or network system. A DataLock unit accepts commands from both a terminal and a computer. The device installs between a terminal and communications lines using a standard RS232C interface. No software or hardware modifications are needed. Any asynchronous protocol may be used. A Bi-sync version will be available in April. Two versions of DataLock are now offered. Model 150 serves a single user. Model 250 can be used as a shared resource for different users and system utilities.

CIRCLE NO. 323

Four-port coupler gives access to 1-GHz signals

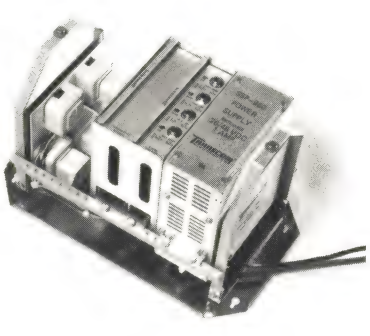


Kings Electronics, 40 Marbledale Rd., Tuckahoe, NY 10707. (914) 793-5000.

A four-port directional coupler, No. 2213-1, gives full access to incident and reflected decoupled waves in the 950 to 1250-MHz band. All ports have a matched VSWR of 1.15. Side port decoupling is 20 dB, ±0.5 dB; minimum directivity, 20 dB; minimum isolation between side output ports, 36 dB. Connectors are gold-plated MIL-39012 type SMA female receptacles. The coupler measures 3.75 × 0.5 × 2.25 in.

CIRCLE NO. 324

Data line bridge cuts leased lines cost



Transcom Electronics, 1170 E. Main Rd., Portsmouth, RI 02871. (401) 683-3000. $348.

A multipoint polling bridge, SSP-406-10, allows coupling of up to five data transmission lines to a single leased line. The factory preadjusted system saves the expense of up to four leased lines. The device installs in about 15 minutes using standard telephone jacks. The unit includes a four-wire amplifier, a bridge, a power supply and a dust cover. Once installed, the bridge is transparent to the user's system.

CIRCLE NO. 325

Selector guides terminals to computer ports

Micom Systems, 9551 Irondale Ave., Chatsworth, CA 91311. (213) 882-6890. P&A: See text.

An intelligent, terminal-controlled switch, Micro600, allows remote users to automatically contend for computer ports. Unlike its predecessor, the Micro600 supports current-loop interface terminals and includes integral Bell 43401 local datasets for short-haul data transmission. A terminal operator can select the class of port to be accessed. A class may represent all ports of a particular computer or it may represent ports supporting a particular application program. Up to 127 different classes may be defined. If ports are busy, an operator may elect to wait in line, in which case the number of terminals already in line will be indicated and a "go" message sent when the turn comes. Any asynchronous terminal can be connected to the port selector. An autobaud features provides automatic terminal speed detection at speeds to 9600 bits/s. A table-top enclosure or floor-standing cabinet are available.

CIRCLE NO. 326

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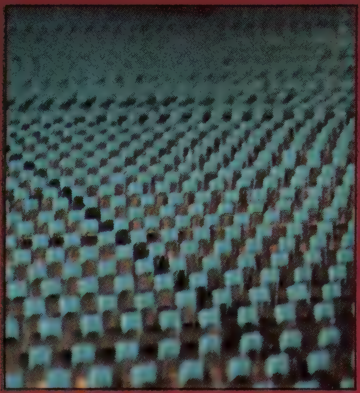

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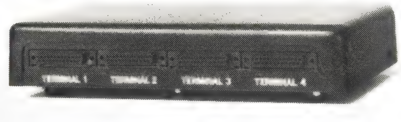
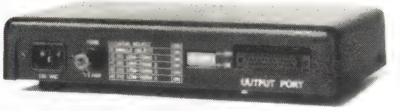
CIRCLE NUMBER 155

Four terminals share one printer/modem/CPU



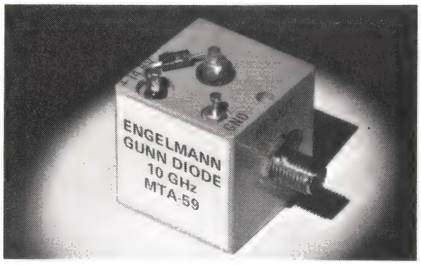


Western Telematic, 2435 S. Anne St., Santa Ana, CA 92704. (714) 979-0363. $295.

A self-powered terminal multiplexer, Model TM-41, allows up to four RS232 terminals to share one printer, modem or CPU. The unit provides three switch-selectable operating modes: an equal priority lockout mode to activate one port at a time, a local mode to allow an OR condition of all four input ports and a multiple mode that activates any of the ports at the same time. In addition, a speed-select mode allows each port to be programmed to automatically switch speeds on a 212 modem.

CIRCLE NO. 394

Gunn diode oscillator gives 100 mW at 10 GHz

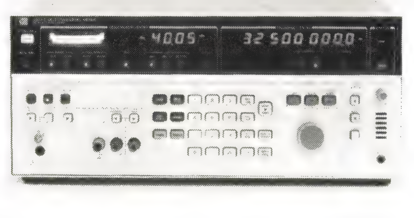


Engelmann Microwave, Skyline Dr., Montville, NJ 07045. (201) 334-5700. $275; 6 to 7 wks.

A Gunn diode oscillator, Model MT-A59, supplies a 10 to 100-mW adjustable output at 10 GHz. Tuning range can be varied by 5%. Frequency stability is 0.25 to 1%, depending on output level setting, over a −30 to +85 C range. The oscillator includes an internal power supply regulator, permitting use of input voltages from 12 to 28 V dc. Overvoltage and reverse voltage protection are provided. Spurious response is −60 dBc; harmonics, −20 dBc.

CIRCLE NO. 395

Selective level meter performs wave analysis

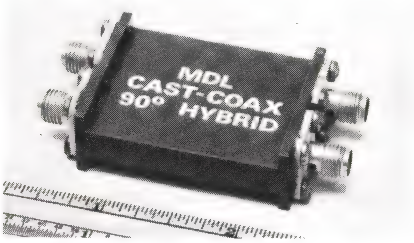


Hewlett-Packard, 1501 Page Mill Rd., Palo Alto, CA 94304. (415) 856-1501. $9100.

A selective level meter, Model 3586C, performs fast and precise wave analysis over a 50 Hz to 32.5-MHz range. Signal levels can be measured from +20 to −120 dBm with ±0.01 dB resolution. Accuracy is ±0.2 dB from 10 kHz to 18 MHz at levels to −80 dBm. Bandwidth choices are 20, 400 or 3100 Hz. Synthesizer frequency resolution is 0.1 Hz. Stability of $\pm 1 \times 10^5$ provides precise tuning to a measured signal. Keyboard operation is fast and accurate. Remote operation is possible via the IEEE-488 bus. Using a standard 20 Hz filter, selective measurements can be made on signals with 80-Hz spacing with 50-dB rejection. A 3100-Hz filter is available for telecommunications channel level or noise measurements with 60-dB carrier rejection and 75-dB adjacent channel rejection. Upper or lower sidebands can be demodulated for further processing.

CIRCLE NO. 396

One-piece 90° coax hybrid gives reliable performance



Microwave Development Laboratories, 10 Michigan Dr., Natick, MA 01760. (617) 655-0060. $75.

A 90° coaxial hybrid for the 8.4 to 10.1-GHz band, Cast-Coax 90°, uses a one-piece, solid aluminum casting to assure repeatable performance. The device measures 1.6 × 1.2 × 0.5 in. and weighs 1 oz. Power capacity is 5 kW peak and 100 W average. VSWR is less than 1.3; isolation, greater than 18 dB; loss, less than 0.4 dB; unbalance, ±0.3 dB maximum. SMA connectors are standard, with other types available.

CIRCLE NO. 397

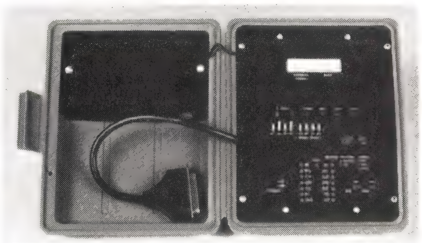
Protocol converter boosts peripheral data rate

KMW Systems, 8307 Hwy 71 W., Austin, TX 78735. (512) 288-1453.

A protocol converter, BAC-HASP, allows operation of a wide variety of peripheral equipment, such as CRTs and line printers, at high data communication rates. The converter communicates with a host mainframe via IBM HASP binary synchronous protocol. The unit performs all error-checking and correction functions, translates EBCDIC to ASCII and ASCII to EBCDIC and interfaces with user-attached devices in serial-asynchronous or byte-parallel formats. Multi-leaving permits console support, duplicate character compression and bidirectional communications. This permits multiple I/O devices to operate at the same time.

CIRCLE NO. 398

Compact data analyzer monitors line performance



Astrocom, 120 W. Plato Blvd., St. Paul, MN 55107. (612) 227-8651. $895.

Maxichek, a compact and portable data analyzer, monitors and simulates data for telecommunications line and equipment evaluation. The unit fits easily into a tool kit or brief case. In the field, Maxichek isolates faults in telecommunications networks by simulating computer terminals or a CPU. Bit error rate or block error rate tests are performed to check modems and phone lines. The device connects to communications lines via an RS232C or CCITT interface. Operation is at speeds of from 110 to 9600 bits/s in the asynchronous mode and at speeds up to 19,200 bits/s in synchronous mode, full or half-duplex.

CIRCLE NO. 399

Op amps slew at 0.25 V/μs and draws very low power

Precision Monolithics Inc., 1500 Space Park Dr., Santa Clara, CA 95050. Russ Schroy (408) 246-9222. P&A: See text.

Very low operating-supply currents do not always demand a sacrifice in slew rates—the OP-21 op amp draws as little as 250 μA while slewing at 0.25 V/μs. The op amp also offers extremely low input offsets—as low as 100 μV on the premium grades and less than 500 μV on all other grades.

The OP-21 comes in seven variations and three grades. The FJ, GJ and HJ operate over an industrial temperature range of −25 to +85 C. The BJ (the military temperature version of the FJ) and the CJ (the military temp version of the GJ) also come in 833 versions. Of the three grades (BJ, CJ and HJ), BJ is the premium op amp.

The OP-21BJ offers the lowest supply-current drain—350 μA, max, at ±15-V supply levels; and 275 μA, max, at ±2.5-V supplies, both with no load. Input offset voltage stays at a low 200 μV, max, 75 μV, typical, and the op amp provides a large signal voltage gain of 800 V/mV, min, 1500 V/mV, typical (with +15-V supplies and a 20-kΩ load). Input offset current gets no worse than 15 nA, and input bias current gets no worse than 150 nA. Except where noted, all these minimums or maximums apply over a supply range ±2.5 to +15 V and over the full temperature range, −55 to +125 C.

The BJ version also has a common-mode rejection ratio of 100 dB, and a power-supply rejection ratio of 105 dB, both with no load. The op amp can handle an input voltage range of −14.5 to +13.5 V. It delivers an output signal of −13.6 to +13.9 V, assuming maximum supply voltages are used.

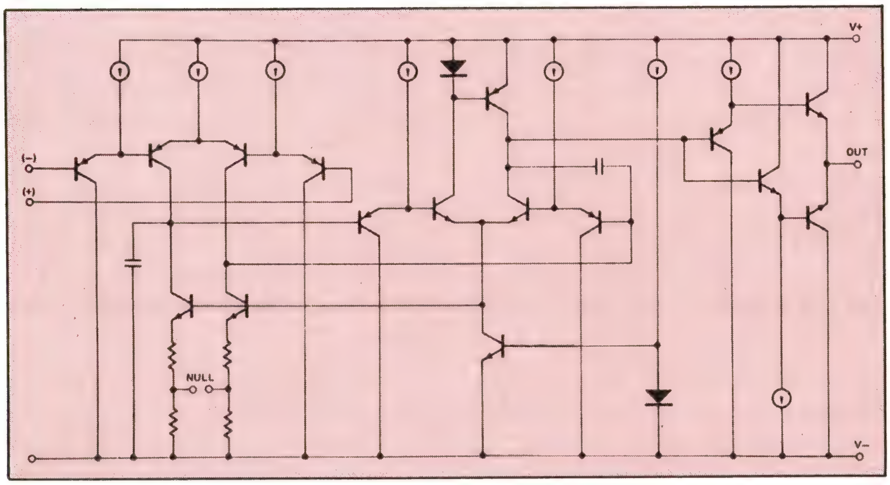
Among its ac performance characteristics at 25 C, the BJ has a closed-loop bandwidth of 600 kHz, typical, with a gain of 1 and a load of 10 kΩ. Its slew rate is 0.25 V/μs, with a load capacitance of 100 pF and a resistance of 25 kΩ. Offset voltage drift with temperature is a maximum of 1 μV/°C.

The specifications for the other versions of the precision OP-21 are very close to the specifications quoted for the premium BJ. For example, the low-cost OP-21HJ has a maximum input offset of 500 μV, an input offset current of 30 nA, an input bias current of 300 nA, a supply current of 475 to 600 μA (depending on supply level), a minimum gain of 500 V/mV, and a reduction of about 15 dB in CMRR and PSRR levels.

Closest competitors include Harris' HA-2720 and National's LM-4250.

The OP-21 BJ costs $16 in the MIL temp version and $19.20 in the 883 version; the CJ costs $11 in the MIL temp version and $13 in the 833 version. The FJ costs $8, the GJ costs $5.40, and the HJ costs $3.80. All prices are for units in 100-piece quantities. Delivery is from stock.

CIRCLE NO. 304



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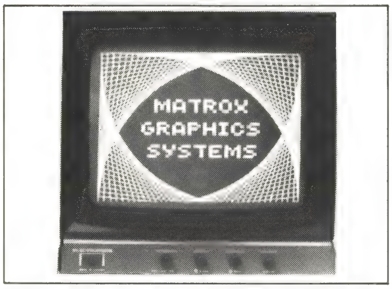
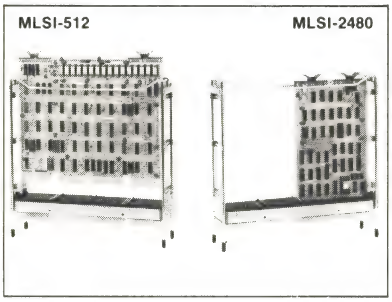
CIRCLE NUMBER 74

matrox

PDP-II and LSI-II bus displays





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LSI-II BUS

MLSI-2480	24 x 80 alphanumerics	$ 350*
MLSI-256	256 x 256 dot graphics	$ 650
MLSI-512 x 256	512 x 256 graphics	$ 850
MLSI-512	512 x 512 graphics	$1150
MLSI-1024	1024 x 256 graphics	$1150

PDP-II BUS

MDC-2480	24 x 80 alphanumerics	$ 350
MDC-256	256 x 256 dot graphics	$ 650
MDC-512 x 256	512 x 256 graphics	$ 850
MDC-512	512 x 512 graphics	$1150
MDC-1024	1024 x 256 graphics	$1150

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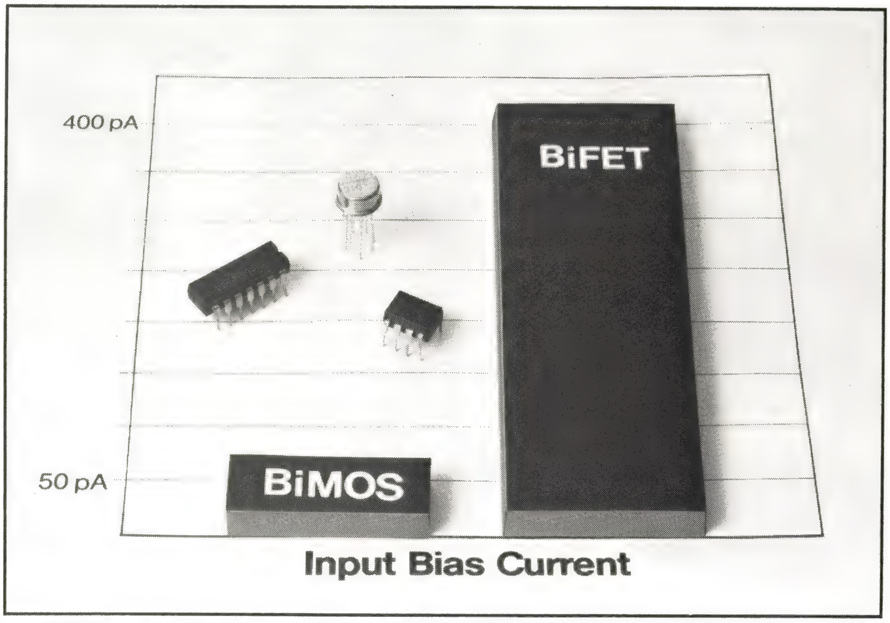
CIRCLE NUMBER 76

BIMOS op amps drop input bias to 40 pA



RCA/Solid State Div., Route 202, Somerville, NJ 08876. George Granieri (201) 685-6420. P&A: See text.

Combining the advantages of MOSFETs and bipolar transistors on the same monolithic chip, a new series of BIMOS operational amplifiers from RCA holds initial input bias current to 40 pA maximum, 15 pA typical. Designated the CA080 series, the new chips are intended as direct replacements for the BIFET TL080 op amps in most applications.

The BIMOS devices mix a MOSFET input with a composite bipolar/MOS output for operation over a wide common-mode input voltage range, ±12 V minimum, and a maximum output-voltage swing of 27 V. Additionally, input impedance is typically a high 10^{12} Ω. Besides a wide output-voltage swing, the composite output provides high output current.

Unity-gain bandwidth for the chips is a broad 3 MHz, and large-signal differential voltage gain is typically 200 V/mV. Also, these BIMOS op amps have a common-mode rejection ratio of 86 dB typical, 80 dB minimum. Power-supply rejection ratio is the same, although it is guaranteed to be 70 dB minimum for some versions.

Input offset voltage depends on the device grade. Some versions hold offset to 3 mV maximum initially, while others keep it to 5 mV maximum over the full operating temperature range. Input offset current also varies, depending on the device grade. At room temperature, offset current is typically held to 5 pA, 20 pA maximum.

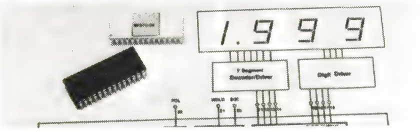
The CA080 BIMOS op amps come in single and dual versions, compensated and uncompensated, and in dual-in-line packages or TO-5 metal cans. The CA080 and the CA081 are single amplifiers, while the CA082 and the CA083 are dual amplifiers. The CA080 and the CA081 can be phase-compensated externally; the CA082 and the CA083 phase-compensated internally.

Applications include inverters, high-Q notch filters, preamplifiers, unity-gain absolute-value amplifiers, sample-and-hold circuits, and active filters.

Single op amps CA080 and CA081 are $0.29 and $0.33 each in lots of 100, and are available from stock. Dual op amps are $0.60 to $0.84, and will be available in production quantities towards the end of the second quarter.

CIRCLE NO. 320

A/d converter puts out multiplexed BCD



Teledyne Semiconductor, 1300 Terra Bella Ave., Mountain View, CA 94043. (415) 968-9241. $4.80 (plastic); $5.30 (ceramic) (100 qty).

A 3-1/2 digit a/d converter, 8751, supplies both a multiplexed BCD data output and a four-digit output. Up to 15 conversions per second are possible. The outputs are suitable for use with LED and gas-discharge displays or for applications requiring microprocessor or printing interfacing. Features include auto-polarity, auto-zero, a display hold input, and end-of-conversion signal and low input noise—30 μV. A display will automatically blank if an input voltage exceeds full scale for the selected input range. Range is set by a reference voltage. The devices are housed in plastic or ceramic 28-pin DIPs. Operating temperature range is −40 to +85 C.

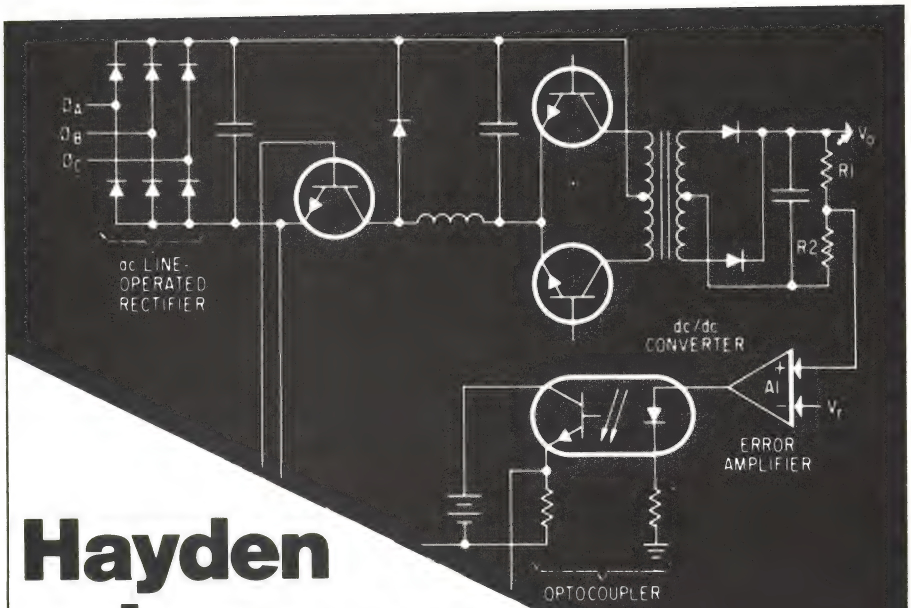
CIRCLE NO. 327

Chip converts positive to negative supply

Intersil, 10710 N. Tantau Ave., Cupertino, CA 95014. (408) 996-5000. $2.25 (100 qty); stock.

A CMOS voltage converter chip, ICL7660, converts a +5 V supply to a −5 V supply with 99.8% accuracy. Loads of up to 40 mA are handled at conversion efficiencies of approximately 97%. The chip will also perform simple negative supply multiplication. The device provides a high-efficiency solution to the problem of obtaining a second negative supply. It tackles the job with fewer external parts and less board space than bipolar approaches. ICL7660 contains a dc power supply, an RC oscillator, a voltage translator and a logic element which senses the highest voltage in the circuit, assuring that the output n-channel switches are never forward biased. When unloaded, the oscillator operates at a nominal frequency of 10 kHz for a 5-V input. The oscillator may be overdriven by an external clock. The device comes in a TO-99 package and is available for two operating ranges: −20 to +70 C and −55 to +125 C.

CIRCLE NO. 328



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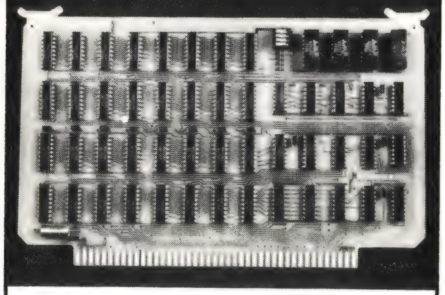
CIRCLE NUMBER 157



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CIRCLE NUMBER 78

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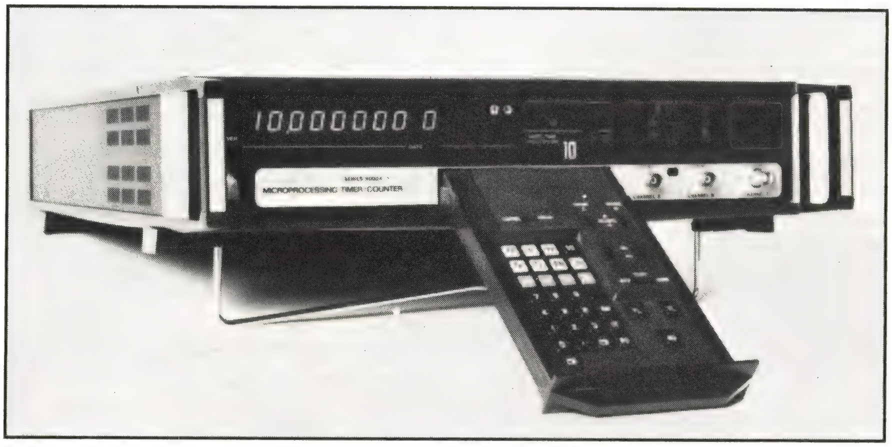
Counter/timers raise handshake speed and add auto-triggering



Racal-Dana Instruments Inc., 18912 Von Karman Ave., Irvine, CA 92715. Norbert Laengrich (714) 833-1234. P&A: See text.

Improved handshake speed and automatic triggering are among the upgraded IEEE-488-bus-performance features and operator conveniences designed into the new Racal-Dana Series 9000 counter/timers.

The handshake speed is the most impressive of the bus-performance enhancements. The time it takes the 9000A counters to transfer one reading over the bus has been cut from 87 ms to 8.7 ms. So instead of taking ten readings a minute as before, the instrument can now do 100.

As a result, test throughput climbs significantly. Moreover, for some applications, like measuring for short-term drift in an oscillator, the higher sample rate produces a more accurate indication of such phenomena.

Besides better throughput, level-1 Remote Local, Device Trigger and Device Clear IEEE-488 subsets have been added to the counter. What's more, Listener has been upgraded to level 4 and Talker to level 5, the highest levels for these subsets.

The added RL1 capability, for one, allows the instrument to respond to a number of commands from a controller in an IEEE-488 system configuration. These include Remote Enable, Local Lock-out, Go to Local, and My Listen Address. With such a diversity of commands, the controller can selectively enable or disable the instrument's control panel—a powerful tool for systems requiring direct interaction with an operator.

With automatic triggering, the operator need only push a button and the instrument's larger 8-bit microprocessor measures the peak-to-peak excursions of the incoming ac signal for a number of cycles to determine the optimum triggering level. It then sets the trigger to a mean value, which is used to minimize triggering errors or false counting due to noise on the input signal during frequency and period measurements.

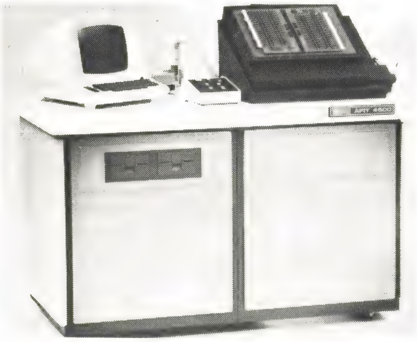
Another operator convenience is added display capability, including a feedback display for entering manual trigger values. Where before the operator would enter a quantity, the LEDs indicating the value would not display anything until the entire quantity had been entered and set. Now, the LEDs show the digits as they are keyed-in by the operator and draw attention to themselves by blinking.

Another improved operator convenience is the ability to recall constants stored in the counter's memory. Previously, an entered constant could only be written over with another value.

The new series 9000A is available in four basic models: 9015A, 9035A, 9015/11A, and 9035/11A. These range in price from $2995 to $4295 in single-unit quantities. Availability is 30 days after order.

CIRCLE NO. 303

Tester pinpoints shorts on bare or loaded boards



Fairchild Testline Instruments, 1400 White Dr., Titusville, FL 32780. (305) 267-7212. From $39,000.

AFIT 4500, a bed-of-nails tests system, detects continuity and shorts in bare or loaded PC boards. Production throughput can be increased by finding board opens or shorts before transfer to in-circuit, functional or system testing. The tester has a basic 2400 test-point capability, expandable to 4096 points in increments of 128 points. A dual solenoid/dual-port option allows alternate testing of two boards on a single fixture. Test speed is 6 to 10 s for a 2400-point board. AFIT 4500 is self-programmable from a known good board. The system learns board topology, generates a test sequence and transfers it to a mini-floppy disk for storage. Test program generation time is typically 8 to 10 minutes. Voltages applied to a board are controlled to prevent device damage. The system is configured as a two-bay, table-height unit with error printout tape, fixture, CRT and operator control unit.

CIRCLE NO. 329

DVOM bounces back from rugged treatment

Hickok Electrical Instrument, 10514 Dupont Ave., Cleveland, OH 44108. (216) 541-8060. $89.95.

LX 304, a 3-1/2 digit, LCD multimeter, withstands rough treatment with no loss of accuracy. A high-impact thermoplastic case and cover protect the instrument from abuse in transportation and storage. The LCD readout is shock-mounted. A 0.01-in. thick layer of GE's Lexan protects the operating panel. Plugs and jacks are recessed and all metal parts are fully insulated for operator safety. Features include automatic polarity and zero and over-range indication.

CIRCLE NO. 330

Probe sniffs magnetic flux density/direction

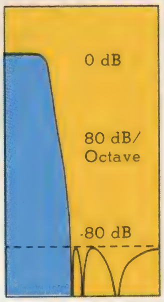
Magnetek, 7315 Red Deer Dr., Boulder, CO 80301. (303) 442-6700. $69.

An ac magnetic flux probe, Model 1846, senses flux density and direction from such electromagnetic equipment as transformers, meters, generators, relays and solenoids. The probe converts flux to a voltage which can be directly measured by a voltmeter or an oscilloscope. Sensitivity is 100 mV/G at 60 Hz. Orienting the probe for maximum output aligns the axis of the unit with the flux field direction. Flux sources, paths and influenced circuitry locations can be quickly identified to determine location of shields, component repositioning or redesign of equipment to eliminate interference.

CIRCLE NO. 331

GOODBYE ALIAS, HELLO GAIN

The new Precision 416 combines filter and amplifier in 16 programmable channels. You save 35% by buying one instrument instead of two for conditioning analog data for digital conversion. Time delay filters superior to Bessel. Elliptics with 80 dB/octave attenuation. DC differential input stage with 100 db CMRR. Both pre-filter and post-filter gain are programmable for optimum signal quality. Both include overload indicators. Interfaces with mini, micro or GPIB. Phase match is less than 2°. **Call Don Chandler,** 607-277-3550, or write for demonstration and complete specs.



PRECISION FILTERS, INC.
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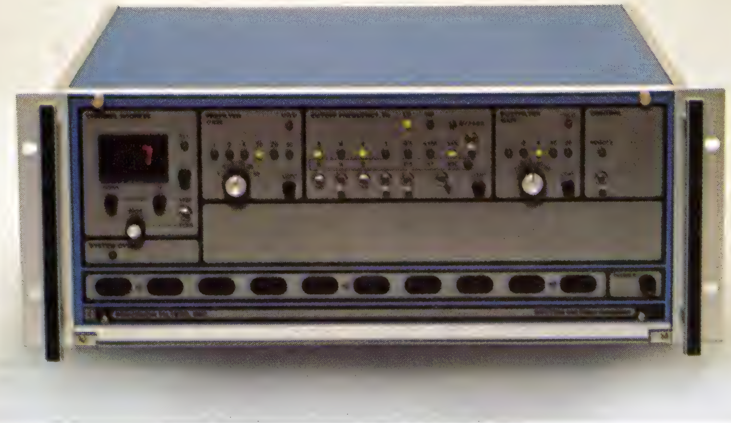
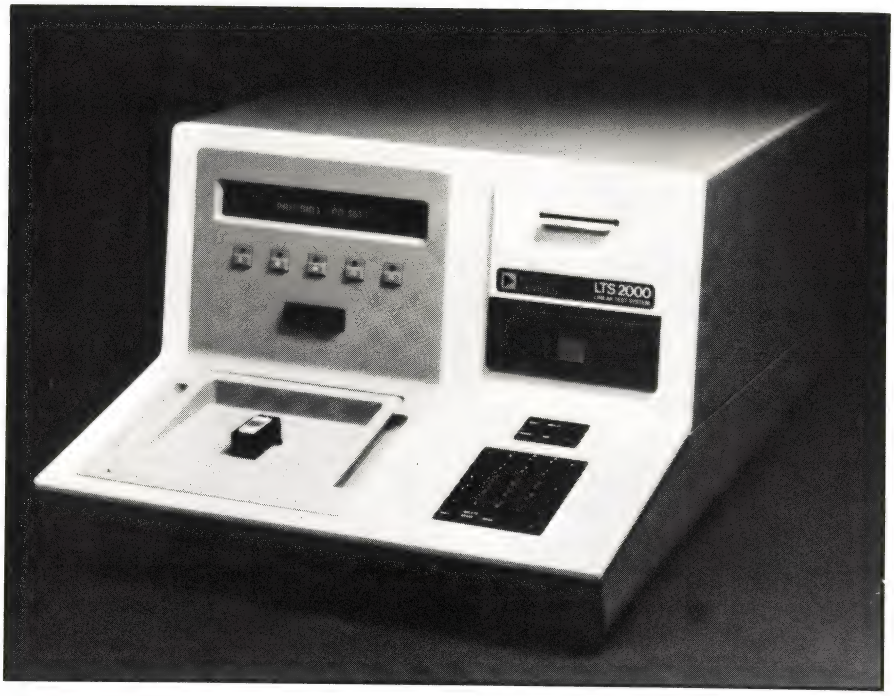


CIRCLE NUMBER 79

First benchtop ADC tester will be a hard act to follow



Analog Devices, Route 1 Industrial Park, Norwood, MA 02062. Roland Johnson (617) 245-9550. P&A: See text.

Although millions of converters pour off assembly lines, the LTS 2000 is the first commercial benchtop tester to attack both analog-to-digital and digital-to-analog converters plus a bunch of other analog products: op amps, comparators, voltage regulators, isolation amps, and so on.

The only other benchtoppers to offer at least some competition are Electro Scientific's two year-old 1262 DAC tester and GenRad's 1731 linear unit, which does not handle converters.

The LTS 2000 brings considerable testing firepower to the production and inspection battleground: It is equipped with integral floppy disk, 20-column thermal printer, 40-character dot-matrix, alphanumeric keypad and IEEE-488 and RS-232 (unidirectional and bidirectional) capability—all under control of a 16-bit T/I 90 microcomputer, backed up by 60 k of RAM and 4 k of EPROM.

Device resolution can go as high as 16 bits, and automatic calibration brings testing to 12-bit (0.01%) accuracy. Typical test times make 10 s for ADCs, 7 s for DACs and 1 s for op amps. The ADC figure includes more than a dozen checks, of such essential factors as linearity and differential-linearity errors, gain and offset errors and conversion times. However, settling times are not checked. With op amps, slew rates reach 1000 V/μs, and the gain-bandwidth product reaches out to 128 MHz.

Can an unsophisticated user operate such a sophisticated unit? In the simplest operating mode of the LTS 2000, a user merely inserts the device, hits a button and reads the pass or fail message. Messages for grading, binning or selection can also be displayed.

Tests and parameters can be set up by either of two routes—with do-it-yourself, fill-in-the-blank programs or with programs provided by Analog Devices. Working from a menu, test personnel can select the order of testing and all parameters; ask for a statistical analysis, printout and external display on a printer or CRT; and make use of the IEEE-488 capability. Both the roll-your-own and factory-assembled programs can be edited. Test levels are set by software-controlled voltage sources.

The LTS 2000 accommodates the various classes of generic devices with a series of family boards and socket assemblies, which plug directly into the tester. Each board carries the circuitry needed for a particular interface; say, an a/d converter or op amp. Setting up a socket requires no soldering, just some jumpers. Future family boards will widen the 2000's horizon to encompass log amps, multipliers, dividers, sample-and-hold circuits, and other functions.

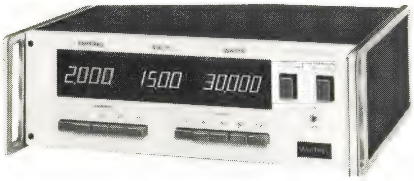
The 2000's autocal takes place every hour or upon user command. If NBS traceability is required, an optional interface cal board—tied in with a Hewlett-Packard 3455 systems DVM via the 488 port—provides that sanction. The cal routine reveals the errors and their locations on a paper-tape printout.

Controls on the Analog Devices tester are grouped into operator pushbuttons, an alphanumeric keypad and system function keys. The operator buttons have no identifiers—software does the labeling by lighting a message on the display directly above the button. The 30-key pad can be used by supervisory staff to set up test programs and enter system limits in response to system prompts. The pad can be locked out, if desired. System functions include Reset, Escape, Display and Disk prompting. The LTS 2000 costs $25,900 with op amp board. The a/d board costs an additional $4000; the d/a board costs $3000.

Stan Runyon
Executive Editor

CIRCLE NO. 391

Digital meter makes fast power analysis



Magtrol, 70 Gardenville Pkwy. W., Buffalo, NY 14224. (716) 668-5555.

A multirange digital analyzer, Model 4612, offers easy measurement of power from 30 to 30,000 W. The microprocessor controlled instrument accepts inputs of up to 50 A and 600 V in five ranges. Ranges are pushbutton controlled and protected against improper selection. Current, voltage and power are simultaneously displayed. Features include display of true rms volts and amperes, with watts representing the instantaneous value of V•A cos θ. Complete isolation, to 1500 V rms, is afforded from power line and test-power source. A front-panel switch, labelled Display Hold, clamps the entire display indefinitely and automatically initiates an integrating mode. Model 4612 handles ac or dc inputs or any combination of the two, including distorted wave shapes. The instrument operates from 115 V ac, 60 Hz or, optionally, 230 V ac, 50 Hz.

CIRCLE NO. 332

Ultra-compact DPM runs on ac power

Datel-Intersil, 11 Cabot Blvd., Mansfield, MA 02048. (617) 828-8000. $70; 6 to 8 wks.

An ultra-compact digital panel meter, DM-3100B, runs on 115 or 230 V ac. The meter measures only 3 × 2.15 × 1.76 in. and provides a 3-1/2 digit LED display with 0.56-in. high numerals. Differential inputs are provided with very high impedance, 1000 MΩ typical. The unit's reference voltage in/out loop can be used in bridge-type and ratiometric applications to compensate for drift in an input signal. Use of CMOS circuitry results in high common mode rejection, 80 dB, to keep down externally induced noise. Input bias current is only 5 pA typical to minimize loading of sensitive input sources. Input voltage is nominally ±1.999 V dc. Blank pads on the meter's circuit board easily accept user-supplied voltage attenuation resistors, current shunts or digital ohmmeter components. Accuracy is ±0.1% (±1 count) of the displayed reading.

CIRCLE NO. 333

Don't be embarrassed if the product you're using doesn't compare to this . .

Lots don't. The PKW-5000, an EPROM Programmer and Z80 Computer, is in a class by itself. With powerful capability, ample functions and excellent reliability, this extremely compact unit is, nonetheless, expandable. It can be used as an EPROM Programmer as well as a simulator and as a debugger. And don't be embarrassed if you thought it costs more than it does.

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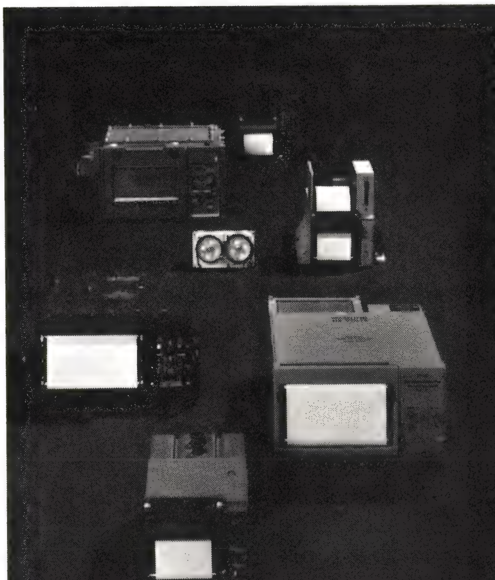
CIRCLE NUMBER 80



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Datametrics Corporation
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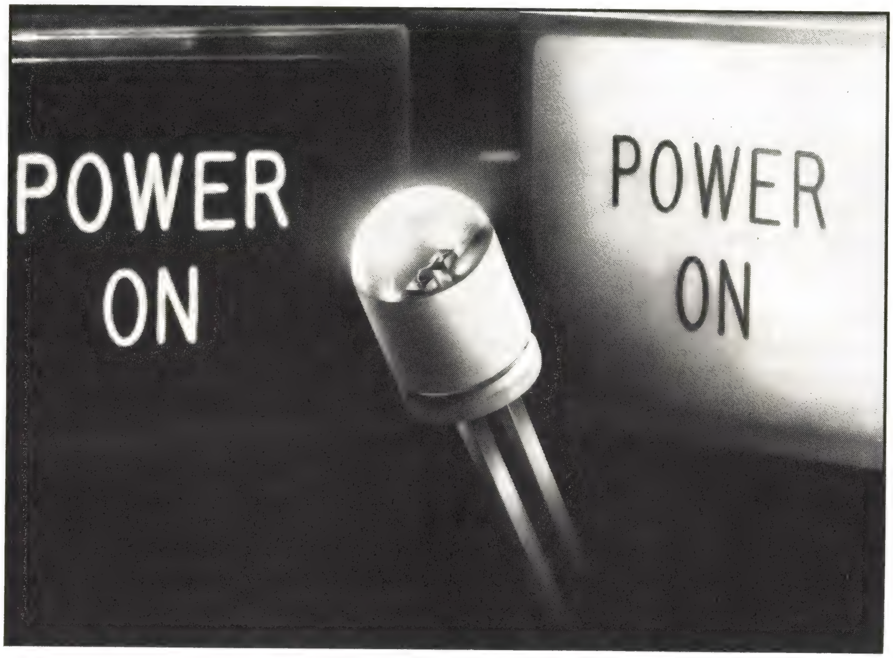
CIRCLE NUMBER 81

High-efficiency LEDs deliver as much light as incandescents



General Instrument, Optoelectronics Div., 3400 Hillview Ave. Palo Alto, CA 94304. Mike Bottini (415) 493-0400. P & A: See text.

By offering a light output almost ten times more than other commercially available LEDs, the Illuminator series of light-emitting diodes combines the high reliability of LEDs with the brightness and size features of incandscent-type displays. The high output results from growing a gallum-arsenide-phosphide epitaxial layer (nitrogen-doped) atop a high-efficiency gallum-phosphide substrate. Each chip formed is a full emitter, producing light in all directions. The output for a filtered-red version for example, reaches to 100 mcd.

What's more, power-input limits for the lamp are below 0.5 W, while panel-illumination area covers 1 × 1 in., and effective life time runs to 1-million hours.

The light output is manipulated by a special package that includes molded plastic reflectors to direct light out through the LEDs plastic lense for a 140° field of view. Each lamp comes in a T-1-3/4 power-lamp package, and contains two series-connected LED chips, each mounted on separate heat sink leads with silver epoxy.

When properly heat-sunk, the LEDs —red, orange or yellow—can operate at a continuous current of 100 mA. The LEDs are current-driven and must use current-limiting resistors when working with constant voltage sources.

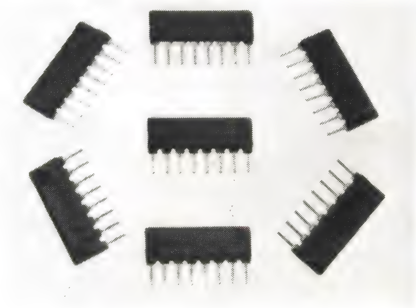
By using two series diodes, the orange and yellow devices have respective forward voltage drops of 4.2 and 4.4 V, minimum. Dynamic impedances at 100 mA are 8 and 9 Ω, and the peak wavelengths are 630 and 585 nm. Both devices have a maximum power dissipation of 625 mW at 25-C case temperature, and must be derated by 10.4 mW/°C for each degree above 25 C. The operating temperature range, though, spans −40 to +85 C.

In large quantities, the LEDs are expected to cost about 60¢ each; in sampling quantities, about $1.30 apiece. The orange MK9150, and the yellow MK9350 both come in −1 and −2 versions, with the −1 offering a minimum luminous intensity of 30 mcd, and the −2 offering a minimum of 60 mcd.

Sample quantities are available now, while production quantities will be early 2nd quarter.

CIRCLE NO. 404

SIP capacitors boost packaging density

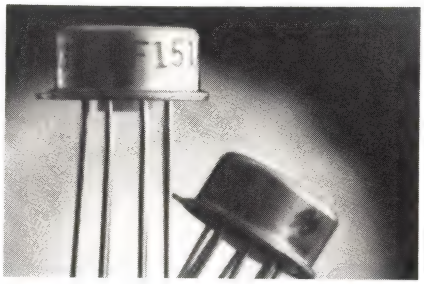


Varadyne Industries, 1520 Cloverfield Blvd., Santa Monica, CA 90404. (213) 829-2984. 8 wks.

A line of ceramic capacitors, packaged in SIPs, allow improved board density and help reduce assembly time. The units come in an 8-pin configuration with conformal coatings of flame-retardant epoxy. A range of 15 pF to 0.01 μF is offered in COG (NPO) or X7R ceramic formulation. The components withstand a temperature range of −55 to +125 C. Tolerances of 5%, 10% and 20% are available.

CIRCLE NO. 334

JFET input op amps operate in military gear



National Semiconductor, 2900 Semiconductor Dr., Santa Clara, CA 95051. (408) 737-5000. $3.25 (LF151); $6.00 (LF153) (100 qty).

JFET input operational amplifiers, LF151, 151A and 153, operate over a full military temperature range. LF151 and 151A single op amps are pin-compatible with the standard LM741. LF153 is a dual op amp, compatible with the LM1558. All three are fabricated using National's Bi-FET process, require low supply current, maintain a high gain bandwidth product and fast slew rate. LF151A, for example, features an offset voltage of 2 mV maximum at 25 C and 4 mV over the military range. Input bias current is 50 pA; input noise voltage, 20 nV/Hz; input noise current, 0.01 pA/Hz; slew rate, 10 V/μs minimum. Settling time is within 0.01% of 2 μs.

CIRCLE NO. 335

Thick-film chip resistors take on high voltages and temperatures

Panasonic Electronic Components, Div. of Matsushita, One Panasonic Way, Secaucus, NJ 07094. Sal Guastella (201) 348-7266. $25 per 1000 in OEM quantities; 16 wks.

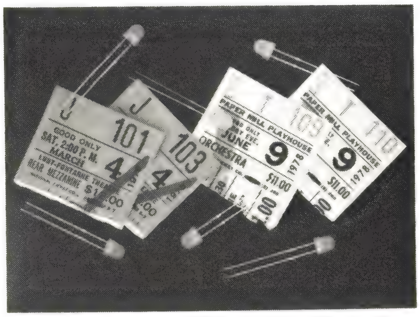
Miniature thick-film chip resistors from Panasonic withstand big voltages, as high as 200 V, and solder heat of 270 C for up to 10 s. The small (0.1260 × 0.0630 × 0.0024 - in.) chips may be the dominant component format in years to come, for applications requiring low cost and miniaturization (such as car radios, calculators, portable radios and portable televisions).

The glazed thick-film resistors are rated for 1/8 W. Resistance values are 100Ω to 1 MΩ with ±2% tolerance; 10 Ω to 1 MΩ with ±5% tolerance; or 4.7 Ω to 10 MΩ with a ±10% tolerance. The operating temperature range is −40 to +125 C, and the temperature coefficient is better than ±1000 ppm/°C.

The chips are made with wrap-around solderable end caps of tinned palladium silver. They are available in bulk form (in plastic bags), in magazine chutes with 200 stacked pieces, or on special carrier tapes that hold 5000 chips on a reel. The magazine chutes and reels can be used with the most modern equipment for high-volume automatic chip placement.

CIRCLE NO. 305

Double chips double use for short-dome LEDs



Opcoa, 330 Talmadge Rd., Edison, NJ 08817. (201) 287-0355. $0.84 to $1.05 (1000 qty); stock.

Two, matched LED chips in a single T1-3/4 short-dome package make a bi-color LED series more versatile for dual-status indicators. The GaP LED chips come in combinations of red, green, yellow and international-orange. Typical luminous intensity is 2 mcd at 20 mA. Uncolored, diffused, epoxy-encapsulated lenses allow a maximum off-axis viewing angle—half-intensity viewing angle is 80°. Matched color units are suited for ac operation. Two-color units give color change with reversal of input polarity.

CIRCLE NO. 336

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CIRCLE NUMBER 82

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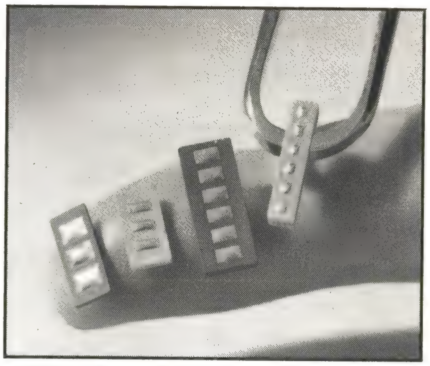
CIRCLE NUMBER 83

Small, customized capacitor plates provide 6 kV of working voltage

RMC - Radio Materials Corp., 4242 W. Bryn Mawr Ave., Chicago, IL 60646. Paul Houlihan (312) 478-3600. P&A: See text.

Miniature capacitor plates withstand up to 6-KV of working voltage for light amplifiers, night vision equipment, military and other specialized applications. RMC's line of custom-made high-voltage plates are intended for very small currents.

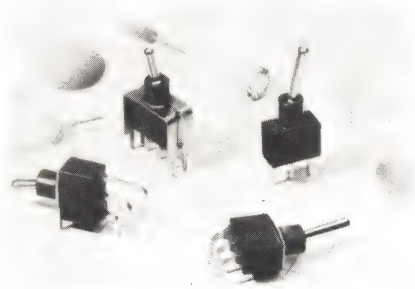
The unpackaged plates come with two, four or six electrodes and provide capacitance values from 20 to 70 pF. The titanate ceramic dielectric produces an insulation resistance of 10,000 MΩ and an X5F temperature-stability characteristic (though COG temperature-stability characteristics can be ordered).



The miniature plates are custom-made from purchaser's drawings. Delivery is 8 to 10 weeks after approval of drawings and samples. A two-section capacitor costs about $0.30 in OEM quantities; a six-section unit is less than $2.

CIRCLE NO. 302

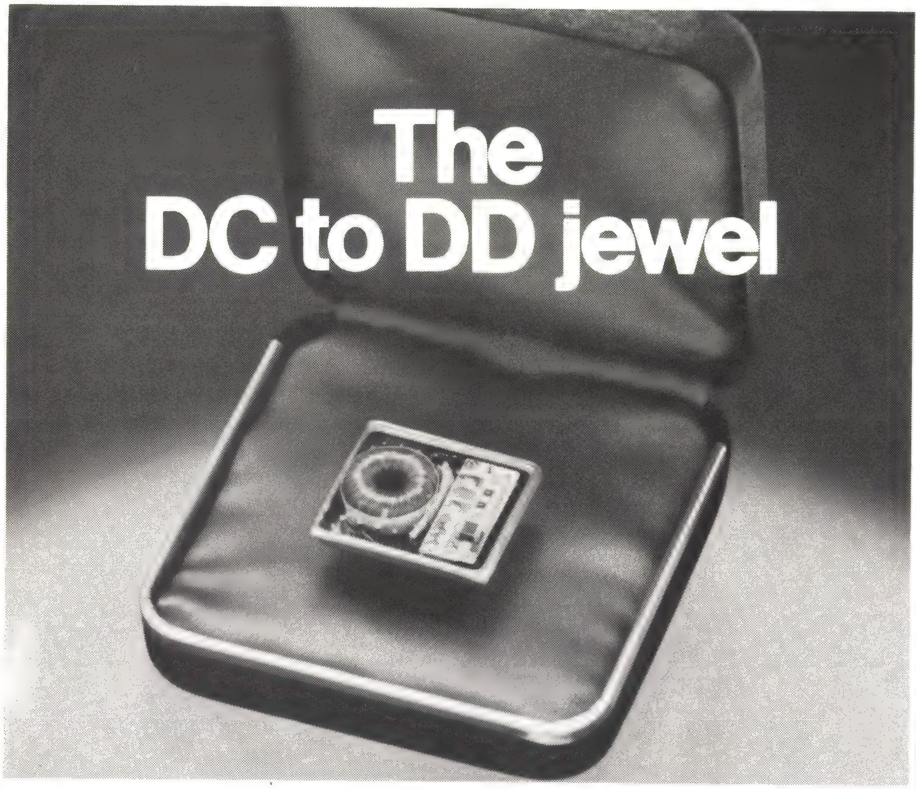
Toggle switch stays clean for automatic insertion



C&K Components, 15 Riverdale Ave., Newton, MA 02158. (617) 964-6400.

E100 Series toggle switches withstand the contaminating effects of wave soldering during PC board assembly. The miniature units block potential leakage paths for flux and solvents to allow automatic insertion. Terminals are epoxy-sealed to the case. The toggle is sealed by an internal O-ring. The top and bottom of the case, high-temperature thermoplastic, are ultrasonically bonded together. E100 series switches are offered in two toggle lengths, four terminal lengths, four mounting versions and five function options. Contact rating is 0.4 VA maximum at 20 V maximum (ac or dc). Contact resistance is 10 mΩ maximum at 2 to 4 V dc and 100 mA. Dielectric strength is 1000 V rms at sea level.

CIRCLE NO. 392



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OUTPUT VOLTAGES	5VDC @ 3 watts to 300VDC @ 3 watts	
OPERATING TEMP.	-55° C ambient to 100° C case, without derating	
DIMENSIONS	1.05 x 0.94 x 0.32 inches	
EFFICIENCY	65% to 75% typically at full load 55% to 60% typically at half load	
PACKAGE OPTIONS AND PRICES	HCN (Non-hermetic)	55.00
	HCH (Hermetic)	65.00
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CIRCLE NUMBER 84

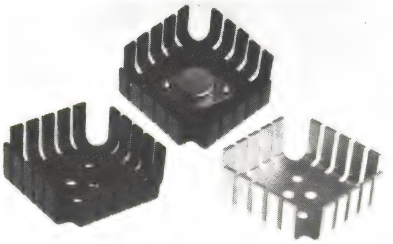
Linear gauge ends error accumulation problems

Shigma, 80 Martin Lane, Elk Grove, IL 60007. (800) 323-0315. $350; stock.

A digital linear gauge, EG-100, overcomes the error accumulation problem inherent in rotary encoder and rack and pinion gauges. The unit finds use in loading tests, measurement of shaft thrust, uneven surfaces, eccentricity and thickness and measurement of irregularly shaped objects. Accuracy is ±0.0001 in. throughout its measuring range. The unit is powered by an ac line or a self-contained, rechargeable battery.

CIRCLE NO. 337

Low-profile heat sink solves space problems



Tran-Tec, P.O. Box 1044, Columbus, NE 68601. (402) 564-2748.

A low-profile TO-3 style heat sink, M1309, provides good packaging density for designers facing a space problem. The device is 0.9-in. high and 2.5 in. on each side. The finned design has a temperature rise of approximately 40 C at 8-W dissipation and is linear from that point—50 C at 12 W, 60 C at 16 W, etc. The cooler is fabricated from 0.09-in. aluminum and is available with a plain or black-anodized finish.

CIRCLE NO. 338

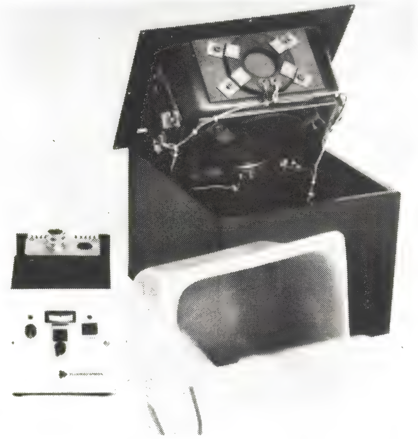
Hand tool installs heavy-duty cable ties

Panduit Electrical Products, 17301 Ridgeland Ave., Tinley Park, IL 60477. (312) 532-1800.

A cable-tie installation tool, GS4EH, handles heavy and extra-heavy cross section cable and lashing ties on bundles up to 12-in. in diameter. The tool provides uniform tensioning and flush cut-off. A "D" ring allows the tool to be hooked on a belt or lanyard. The tool installs cable ties having 120, 175 and 250-lb loop tensile strengths, widths from 0.3 to 0.5 in. and lengths of up to 40 in.

CIRCLE NO. 339

Lined hot pot keeps semi chemicals cooking

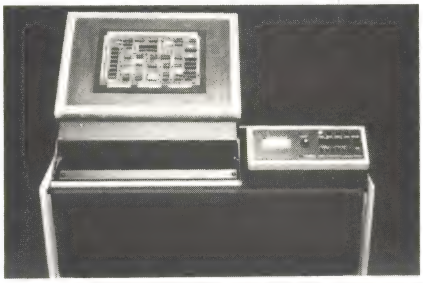


Fluorcarbon, 1432 S. Allec St., Anaheim, CA 92803. (714) 956-7330.

A constant temperature bath, Hot Pot II, lined with DuPont FEP Teflon, resists the corrosive effects of most solutions used in semiconductor processing. Long-term temperature stability is ±2 C over an operating temperature range of 30 to 180 C. Ring-type, enclosed resistance heating elements mount directly to an inner tank. Temperature is controlled by a digital setpoint controller. The seamless liner protects against contamination and corrosion from such acids as hydrofluoric and hot sulfuric.

CIRCLE NO. 340

Board tester pre-screens for connectivity problems



GenRad, 300 Baker Ave., Concord, MA 01742. (617) 369-4400. $18,500.

An in-circuit continuity test system, 2245, improves productivity by prescreening bare and loaded PC boards for connectivity problems. The microprocessor-directed unit measures resistance values from 10 Ω to 10 kΩ and will check pull-up, pull-down and ECL resistors used in computers and peripherals. The 2245 pinpoints such process errors as under or overetch, poor wash and uneven cladding. Equipped with a bed-of-nails fixture, the test system accepts a fixture change to test backplanes, cables and box wiring. Typical board test time is 1 to 2 s. Diagnostic messages are reported at 1 s/fault. A built-in 20-column printer gives easy access to diagnostic information. Multiple test programs can be stored on the unit's cassette tape drive for fast program loading.

CIRCLE NO. 341

Laser scribes patterns on pre-aligned substrates

Compulaser, 6733 Eton Ave., Canoga Park, CA 91303. (213) 992-1456. 13 wks.

A pre-alignment station and a computerized numeric control (CNC) stage assist a Q-switched YAG laser in the Model KSLS laser scribing system. The pre-alignment station permits alignment of a ceramic or silicon substrate on a vacuum chuck using a split-field microscope. Pre-alignment occurs while a previously aligned substrate is being scribed. Switching chucks allows scribing to resume in a matter of seconds with no slowdown in production. The stage controller permits simple programming of virtually any scribe pattern. The pattern can be stored in memory and recalled by a two-digit reference code. The controller allows cutting of X-Y patterns, circles and alphanumerics for substrate identification. Standard resolution is 1 mil with optional resolution of up to 0.1 mil.

CIRCLE NO. 342

Terminal handles data at the touch of a finger

Carroll Manufacturing, 1212 Hagan St., Champaign, IL 61820. (217) 351-1700. $2600.

Merely touching the surface on the CRT screen of Carroll Manufacturing's Touch Terminal completes man/machine interaction for data entry, information retrieval or any related data-handling requirements. A low-cost package—only $2600—the terminal is based on Datamedia's 3025A CRT terminal and Carroll's scanning infrared-beam technology.

Phototransistor detectors and IR-LED emitters, mounted on opposite sides of a "window frame" assembly, criss-cross the face of the CRT with a matrix of IR light beams. Each point at which an X and Y axis beam intersect is a designated touch point, specifying a location on the CRT's face. The window area is scanned repeatedly by sequentially pulsing the LEDs along each axis. Touch activation occurs whenever both an X and Y beam are interrupted.

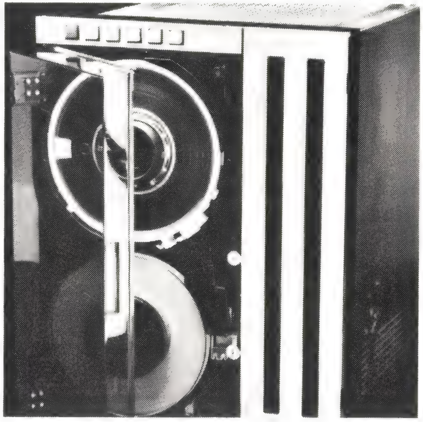
The terminal is Teletype compatible and stores a single page of video information. Standard RS232C or optional 20-mA current-loop interfaces support full or half-duplex, two or four-wire asynchronous communications. Screen capacity is 1920, 5 × 9 matrix, characters.

Touch targets can be located anywhere on the display's face. Software resolution almost doubles 960 touch-active points to 1896 programmable touch points.

The Touch Terminal lends itself to a broad range of data entry jobs, some of which preclude the use of keyboards. For example, touch entry eases terminal use problems for handicapped persons or those working in hostile environments.

CIRCLE NO. 309

Tape memory stores up to 180 Mbytes for PDP-11/70



System Industries, P.O. Box 9025, 525 Oakmead Parkway, Sunnyvale, CA 94086. (408) 732-1650. Under $35,000.

Omega, a 6250-bits/in. magnetic tape storage system, offers up to 180 Mbytes of data storage for DEC's PDP-11/70 computers. The unit emulates the slower and lower capacity DEC TU45 unit. The system includes a tape transport, a formatter and a tape adapter. The transport, controlled by the formatter, operates at a speed of 75 in./s. In GCR mode, the system records data at 6250 bits/in.; in PER mode, 1600 bits/in. Modes are switchable and programmable.

CIRCLE NO. 393

3 Families of control knobs at affordable prices.

ALUMINUM SERIES Ours are better because they are totally machined without compromise, even the knurls. Other features include: durable anodized finish, two stainless steel set screws, all edges chamfered and the recessed bottom clears mounting nuts.

LEXINGTON SERIES This series is molded from high quality phenolic resin in black or red. All have aluminum spin plates, brass bushings for added strength and allen set screws.

COLLET SERIES A unique mounting technique is used which allows a firm attachment to any shaft without the use of exposed set screws.

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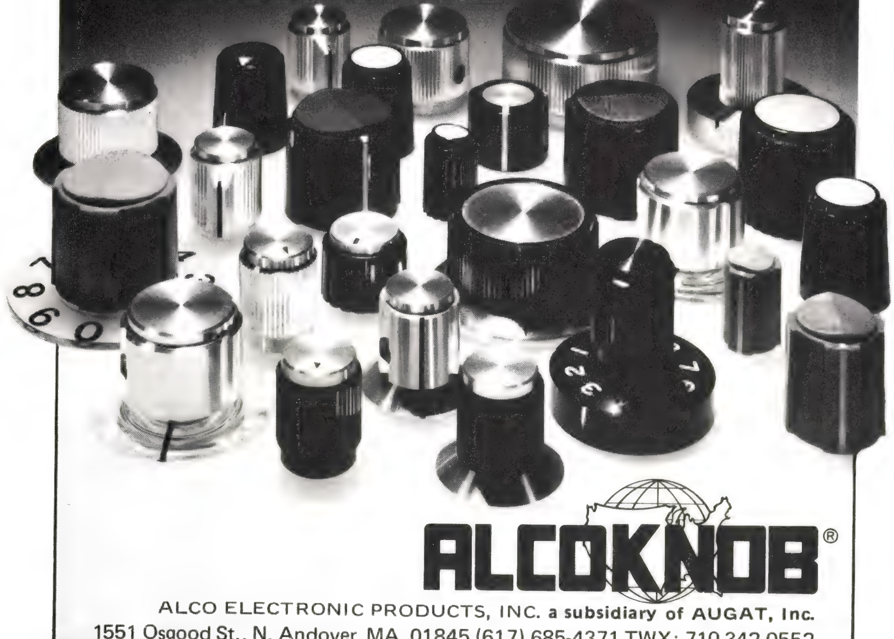

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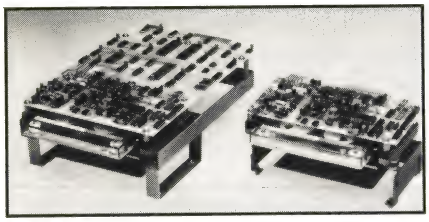
CIRCLE NUMBER 85

10 and 20-Mbyte streaming-tape drives provide low-cost Winchester backup



Data Electronics, Inc., 11633 Sorrento Valley Rd., San Diego, CA 92121. Sam Thompson (714) 452-7840. P&A: See text.

Two low-cost streaming-tape drives provide 8-in. Winchester-disk backup at capacities ranging from 10 to 20 Mbytes. Both drives feature standard ¼-in., ANSI/ECMA-compatible data cartridges and are physically compatible with industry-standard slots for floppy-disk drives.

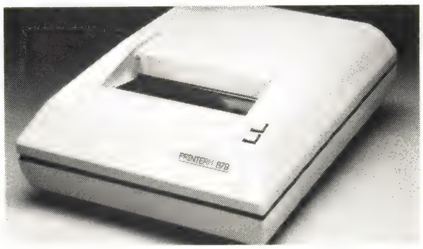
The two-track, 10-Mbyte and four-track, 20-Mbyte drives can transfer 5 Mbytes of data per minute with a data reliability of less than one read error in 10^{10} bits. Data Electronics error-detection and correction circuitry is optional.

The drive interface looks like a semiconductor FIFO memory to the system. In addition, both drives are powered by a 5-V and a 24-V supply, with a total dissipation of 45 W.

Available in small quantities immediately, the drives sell for $746 (10-Mbyte) and $788 (20-Mbyte). For anyone wishing to supply his own streaming electronics, Data Electronics will provide stripped versions for $415 (10-Mbyte) and $525 (20-Mbyte).

CIRCLE NO. 306

Low-cost printer wants no-frills jobs



Printer Terminal Communications, 124 Tenth St., Ramona, CA 92065. (714) 789-5200. $999.

A receive-only serial printer, Model 877, aims at no-frills applications, where reliability is more important than additional features. The microprocessor-controlled, bidirectional unit uses a 9 × 7 dot matrix. A cartridge ribbon eliminates need for ribbon reversing mechanisms. Print speed is 120 char/s at 80 char/line and 10 char/in. A 95-character ASCII set is used. The internally-contained, 8-1/2 in. paper roll is friction fed. A higher-performance version, Model 879, offers speeds of up to 180 char/s and sprocket-feed for fanfold forms. Format control is a standard Model 879 feature.

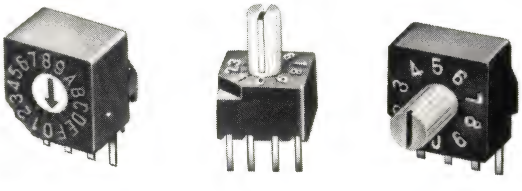
CIRCLE NO. 343

Perfectly Sealed

COPAL

Digital Rotary Switches

S-1000, S-2000 Series



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*Perfectly sealed; gas proof and washable
*No soldering problems
*Sure click action
*10 and 16 positions available
*Suitable for various digital setting
*DIP pins

For further information, contact:
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CIRCLE NUMBER 86

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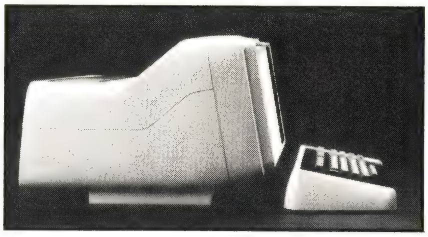
CIRCLE NUMBER 87

Stand-alone CRT terminal prospers in distributive processing locale

ECS Mircosystems, 215 Devcon Dr., San Jose, CA 95112. (408) 286-4200. P&A: See text.

A multiprotocol intelligent terminal from ECS Microsystems exhibits a flair for distributive processing along with power for stand-alone computing. The 4500 Series enters the U.S. market via the new California headquarters of the Australian company. All major mainframe protocols are supported, including those from IBM, DEC, Burroughs, Hewlett-Packard, Honeywell, NCR and ICL.



As a stand-alone data processor, ECS 4500 uses a comprehensive variety of development and applications software. Specialized applications draw on Basic, Cobol and Assembler languages to suit most programming requirements.

In a distributed processing environment, the terminal combines its 983-kbits of disk storage and its Z80 microprocessing power to serve a range of protocols. Communications is at 75 to 19.2 kbaud, RS232C synchronous or asynchronous. Parallel interface is offered, as is full modem control in multidrop configurations.

The CRT display is memory mapped for scrolling. Four intensity levels, plus underline, reverse video, double-width characters and underline blink, can be used in any combination. A proprietary Hall-effect keyboard, with N-key rollover, uses tactile-feel keys to reduce keystroke errors by the operator. Modernistic packaging makes the unit at home in both the lab and the front office.

A typical configuration (with 64-k RAM, operating systems, Utilities and Basic) would cost $6100, in quantities of 20, including setup and training. Delivery is 6 weeks.

CIRCLE NO. 310

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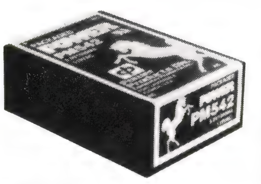
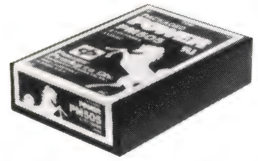


PM542

5.0V @ 1A.Regulation: ±0.02% Line/±0.04% load. 1.0mV RMS Ripple/Noise. Built-in overvoltage protection. Powers all popular digital logic. $45.00*



PM505

±15V @ 100mA. Regulation: ±0.02% Line/±0.02% load. 0.5mV RMS Ripple/Noise. 50 megohms input isolation. Ideal for powering op-amps and precision instrumentation. $33.00*

PM396

±15V @ 500mA. Regulation: ±0.05% Line/±0.05% load. 1.0mV Ripple/Noise. Chassis-mount model for use with linear IC and discrete analog circuits. $78.00*

*(*OEM quantity price)*

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CIRCLE NUMBER 88

Tape cassette performs in DEC computers

Magnetic Information Systems, 415 Howe Ave., Shelton, CT 06484. (203) 735-6477.

A computer tape cassette, 520 DEC, performs well in DEC computer systems. Large diameter hubs are used to keep tape speed constant and eliminate mechanical jitter. One-mil tape provides good tensile strength. The cassettes are certified for 1600 fc/in.

CIRCLE NO. 389

Image digitizer produces 8-bit digital data

Eikonix, 103 Terrace Hall Ave., Burlington, MA 01803. (617) 273-0350.

An image digitizer, EC782, produces 8-bit digital data from transmissive and reflective copy. A 2048 × 2048 pixel image is generated in less than 60 s; a 1024 × 1024 pixel image, 18 s. The digitizer uses a linear photodiode array that is mechanically stepped to produce square or rectangular formats.

CIRCLE NO. 344

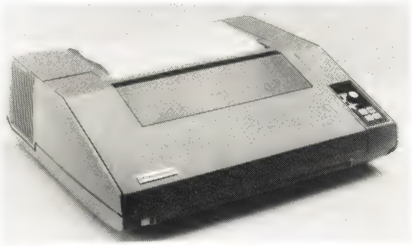
Programmer tackles 2708 and 2716 types

RMD, P.O. Box 206, Bristol, PA 19007. (215) 949-2588. $895; 6 to 8 wks.

An EPROM programmer, Model 7816, cuts programming costs for users of 2708 and 2716 types. A dedicated device, the programmer avoids the additional costs associated with universal, multiple PROM units. Model 7816 provides editing features, allowing a user to read, correct and verify data before committing it to PROM. Data from multiple PROMs can be merged. Master and copy sockets are protected. An RS232C serial interface is provided.

CIRCLE NO. 345

Lower-cost printer offers 180 char/s speed



Dataproducts, 6200 Canoga Ave., Woodland Hills, CA 91365. (213) 887-8451. From $1350 (OEM qty); 4 wks.

An impact printer, Model M-120, provides crisp, easy-to-read print using a 7 × 7 half-dot matrix font in standard or expanded characters. Print speed is 180 characters/s in a bidirectional, logic-seeking mode. Work throughput ranges from 75 lines per minute for full, 132-character lines to 200 lines per minute with 40-character lines. Average throughput is 120 lines per minute. Like its predecessor, the M-200, the M-120 includes a self-test feature. An optional LED diagnostic display indicates which cycle the printer was in at the time it went off-line.

CIRCLE NO. 346

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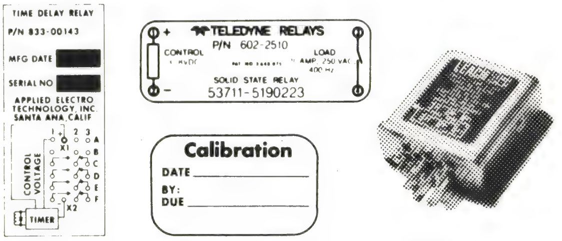

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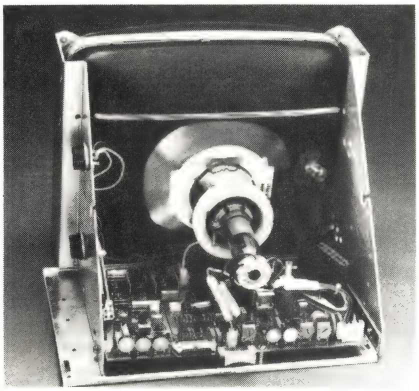
CIRCLE NUMBER 89

CRT monitor nestles into OEM display designs



Telex Computer Products, 6422 E. 41st St., Tulsa, OK 74135. (918) 627-1111. $260 (OEM qty); 8 to 9 wks.

A high-resolution CRT display, HR-1500, provides 400 active raster lines for OEM data display products. The monitor produces over 1920 characters in white or green phosphor. Horizontal scan rate is 25 kHz; refresh rate, 50 or 60 Hz. Features include vertical step scan, dual intensity characters, a 15-in. diagonal screen with an etched, bonded faceplate for no-glare viewing and a 110° deflection angle for use in compact enclosures. All electronics are contained on a single PC board to reduce the number of interconnections and increase monitor reliability.

CIRCLE NO. 347

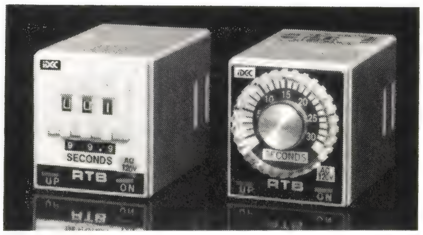
Process indicator powers two-wire transmitters

Action Instruments, 8601 Aero Dr., San Diego, CA 92123. (714) 279-5726.

A built-in 24-V dc power supply in the VIP509 digital process indicator eliminates need for a separate loop supply. The unit simplifies wiring and installation of two-wire transmitters. The unit can be scaled to display process variables in direct engineering units, such as °F, °C, rpm, gpm, etc. The indicator itself operates directly from a 120-V ac line. Rear-accessed screwdriver adjustments provide ±15% typical zero and span adjustability. Options for the 3-1/2 digit unit include an open-loop indicator and a 5-mA analog output, corresponding to the two-wire transmitter output span, for driving recorders or controllers.

CIRCLE NO. 348

Time delay relays keep accuracy with RC counting

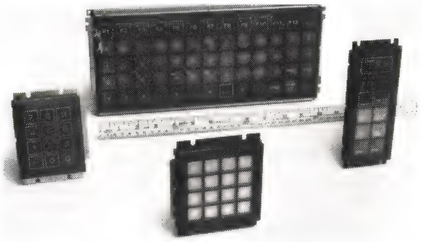


IDEC Systems & Controls, 3050 Tasman Dr., Santa Clara, CA 95050. (408) 988-7500. Approx. $30 to $64; stock to 8 wks.

RTB Series miniature timers attain high repeatability using RC-oscillation counting rather than RC-threshold sense. Repeated accuracy is ±0.2% or less. The electronic time delay relays come in digital or dial-set styles with 8-blade or 8-pin octal terminals. Two independent relays are contained within each timer: one for delay, the other for instantaneous output. Output contacts provide up to 10-A capacity. Protection is afforded against electrical surges and noise. Time settings range from 6 s to 100 min. Models are available for 120 or 240 V ac (50/60 Hz) and 24 V dc. Dial-set types measure 1.6 × 1.44 × 2.46 in. Digital models are 1.6 × 1.44 × 2.38 in.

CIRCLE NO. 349

Covering sheet protects tactile keyboards

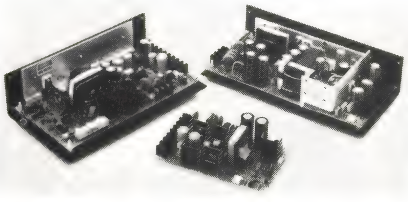


Fujitsu America, 910 Sherwood Dr.-23, Lake Bluff, IL 60044. (312) 295-2610.

A covering sheet over a series of tactile keyboards gives protection from dust, oil, water and other materials which can damage keyboard switches. The covering sheet is sealed to the keyboards' base plate. The keyboards use an open-contact keyswitch with a soft, snap-action keytouch. A plate spring/actuator permits a rhythmical snap touch. A precious-metal coated, multipoint contact system assures reliable switching. The low-profile keyboards come in a wide variety of indicator designs, including multicolor, full words and special characters.

CIRCLE NO. 354

Switcher allows wide load range on all outputs

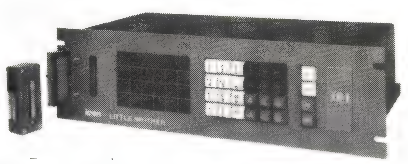


Boschert, 384 Santa Trinita, Sunnyvale, CA 94086. (408) 732-2440. $84 (XL25); $197 (XL75); $262 (XL130) (100 qty); 8 to 13 wks.

XL series switching power supplies maintain tight regulation on all outputs while allowing load changes of up to 10:1. Magnetically-coupled regulation compensates for voltage centering (variations due to component changes), temperature variations and line voltage changes. The first three models in the series are the 25-W XL25, the 75-W XL75 and the 130-W XL130. User-selectable ac ranges are 90 to 130 V and 180 to 265 V. Ac frequencies can vary from 47 to 440 Hz on either voltage range. Primary output is 5 V with ±1% regulation over a 5:1 load change. Secondary outputs are −5, +12 and −12 V with ±3% regulation over a 10.1 load change. Regulation figures include all line, centering, temperature and load changes. All units have overvoltage and short-circuit protection. Holdup time is 16 ms minimum.

CIRCLE NO. 355

Controller automates point-to-point positioning

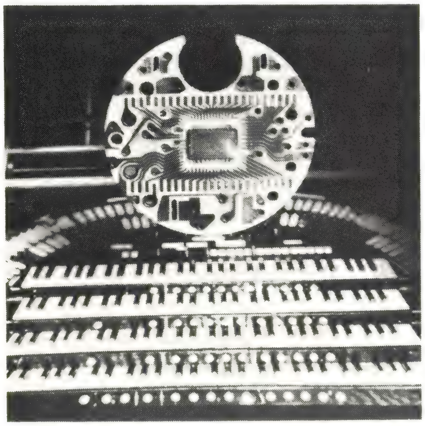


Icon, 156 Sixth St., Cambridge, MA 02142. (617) 868-5400. $1500.

A programmable controller, LB-1 Little Brother, provides simultaneous two-axis, point-to-point positioning for absolute or incremental dimensions. Feedrates for each axis are separately programmable. The unit includes four, optically-isolated, relay outputs and four isolated limit switches. A LED display indicates all functions, including the absolute position of each axis. Other features of the rack-mountable unit include program dwell, mirror image, absolute position pre-set, subprogram/call/repeat and conditional execution demands.

CIRCLE NO. 356

Watch chip draws music from ROM-based memory



OKI Semiconductor, 1333 Lawrence Expwy., Santa Clara, CA 95051. (408) 984-4840. $4.30 (100,000 qty).

A wristwatch chip, MSM5016, uses on-chip ROM and frequency generators to produce approximately one minute of music. A possible precursor of a speech product, the music chip generates tones ranging in duration from 64th notes to dotted whole notes. The CMOS circuit provides all signals needed to drive an LCD watch of six digits, ten flags and two information segments. Oscillator RC network components are included on the circuit.

CIRCLE NO. 357

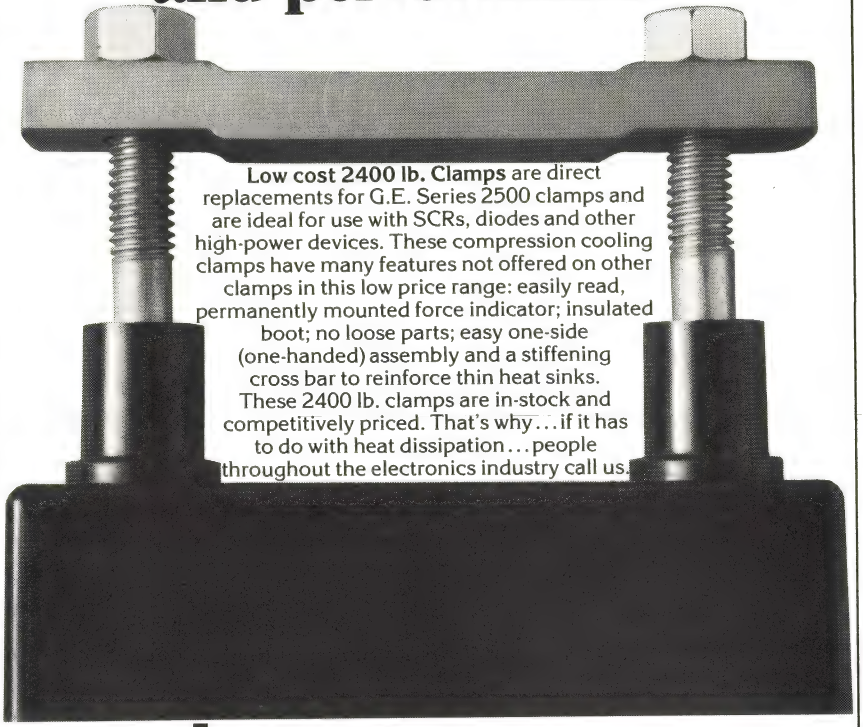
Schottky octal transceiver speeds data to processors

Monolithic Memories, 1165 E. Arques Ave., Sunnyvale, CA 94086. (408) 739-3535. $5 (100 qty).

A low-power, Schottky, bipolar octal (8-bit) transceiver, SN74LS645, allows asynchronous, two-way communications between data or address buses connecting processors, controllers and memories. The device consists of eight receiver/driver pairs forming a complete bus interface. The 8-bit structure is compatible with 8, 16, 24 and 32-bit data widths. Three-state, TTL-compatible outputs interface directly with address and data buses. A directional control input determines direction of data flow. A separate input disables the device and establishes bus isolation. A single 5-V supply, capable of 110 mA, is required. The device provides a maximum output sink current of 24 mA. Plastic or ceramic 20-pin DIPs are available.

CIRCLE NO. 358

Put the pressure on price and performance.



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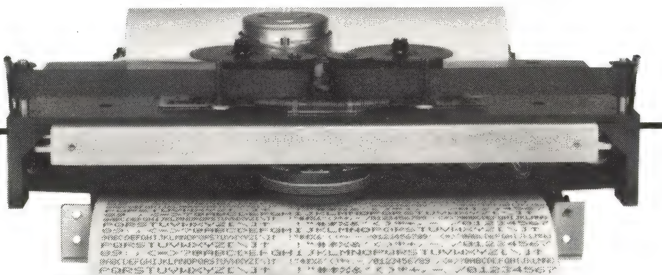
CIRCLE NUMBER 90



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Don't let the low price tag fool you; our DMTP-6 μP is stronger on capabilities than any printer in its class. Its unique matrix impact print head lets you program any desired character pitch. You can print data or text, single-stroke or enhanced from 36 to 132 columns. And, print up to four copies without adjustment on standard 8½" roll paper, fan-fold forms and labels.

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CIRCLE NUMBER 91

Etchant works fast to dissolve gold and enhance its recovery

Union Etchants International, Inc., 8-10 Green St., Building G, Woburn, MA 01801. Richard Sykes (617) 935-8878. $18/qt; 2 wks.

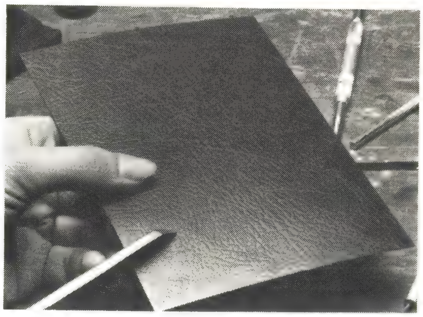
A cyanide-free etching solution, the EIAU1 dissolves vacuum-deposited or flash-plated gold with little undercutting of the interconnect lines and without affecting the photo-resist patterns.

The typical etching rate for 24-karat gold thin films is 500 to 800 Å per second at 40 to 50 C. Because the etched gold does not crystallize, gold recovery from the Union Etchant's solution is enhanced.

The iodine-based etchant is available as a powder, concentrate or premixed solution. Since it contains no cyanide, it conforms to OSHA safety regulations when used. In solution, the specific gravity is a consistent 28° Baume. The etchant is useful for hybrid microcircuits, chip carrier beds and other miniature interconnection systems.

CIRCLE NO. 307

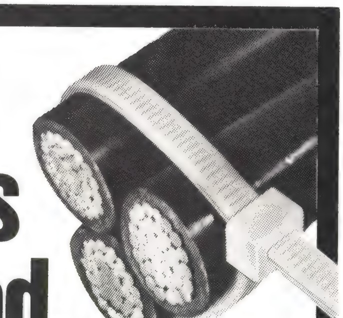
Add leather-look surface to equipment enclosures



General Electric Plastics, One Plastic Ave., Pittsfield, MA 01201. (413) 494-5475.

A leatherette-texture Lexan film adds styling options to electronic equipment enclosures. The film, ranging in thickness from 10 to 20 mil, applies to surfaces via a simplified adhesive system. The film endures heat up to 270 F, permitting high-temperature use in close proximity to illuminating sources. Dimensional stability is maintained at elevated temperatures, allowing perfect registration after heat drying cycles. The film can be screen printed without surface preparation or special inks.

CIRCLE NO. 359



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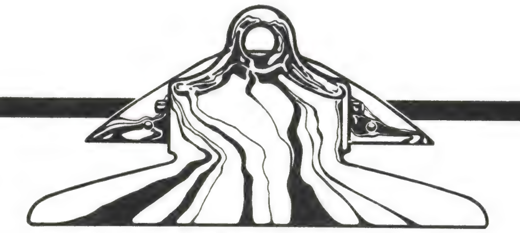

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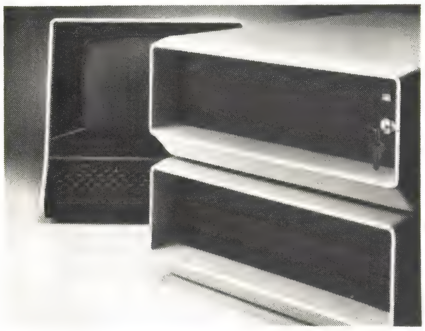
Fast 8-bit μC crunches numbers at 7-MHz rate



Artec Electronics, 605 Old County Rd., San Carlos, CA 94070. (415) 592-2740. $8025 to $10,825. stock.

A fast 8-bit microcomputer, Centurion, processes data at a 7-MHz rate. Built around Intel's 5-MHz 8085A-2 microprocessor, the computer boosts processing speed with the help of a floating-point math chip for number-crunching tasks. The Centurion includes 16-k of internal PROM, 64-k of RAM, a floppy-disk controller, Digital Research's CP/M operating system and a shielded motherboard. The computer operates with a CRT terminal and up to four, single-sided, double-density, 8-in. floppy-disk drives. Any printer with an RS232 interface can be used. A Centurion system comes in three configurations, differing in packaging and peripheral options. An additional Mbyte of disk storage, in the form of two 8-in. drives and a power supply in a separate enclosure, can be added.

CIRCLE NO. 360

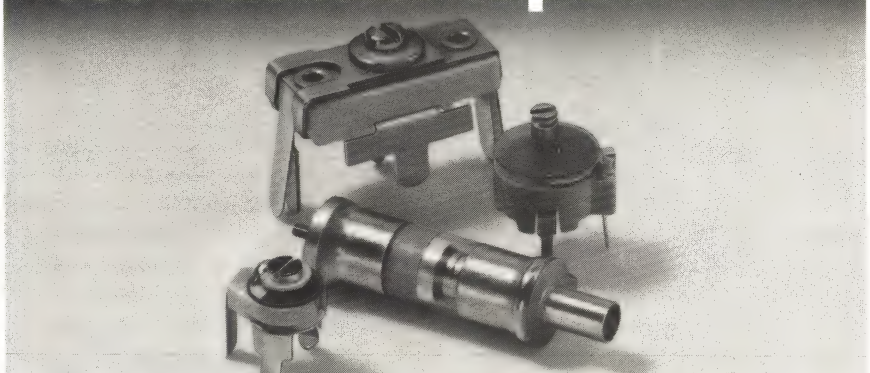
Real-time executive allows more tasks on Z80/8080

Systems & Software, 2801 Finley Rd., Suite 101, Downers Grove, IL 60515. (312) 932-9320.

REX-80 VO3, a real-time executive, supports 8080/8085 and Z80-based microcomputers. The software is fully event driven, allowing asynchronous operation of up to 255 independent tasks, each with 16 local event flags. Versions for both types of computers offer source or object formats and may be ordered for most popular development systems, including Intel MDS, Zilog PDS, Tektronix 8000 series and minicomputer systems using cross assemblers.

CIRCLE NO. 361

Sprague-Goodman. The first and last name for trimmer capacitors.



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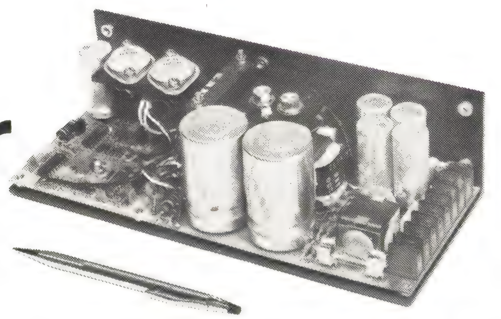
CIRCLE NUMBER 92

The Power Saver®



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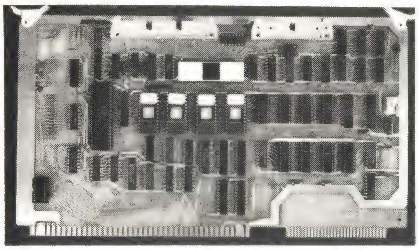
POWER DYNAMICS CORP.
9421 Telfair Avenue, Sun Valley, CA 91352

CIRCLE NUMBER 93

Floppy disk controller directs up to 8 drives

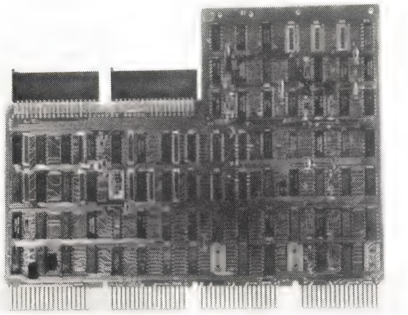


Professional Resources Technology, 504 Vandell Way, Bldg. E, Campbell, CA 95008. (408) 378-5610. $935.

A smart floppy disk controller. FDC-100 M, directs the operation of from one to eight Shugart-compatible drives. The board, compatible with Intel's Multibus, provides all control functions for formatting, sector read/write, drive select and head positioning. The programmable unit uses an 8085 microprocessor and can be configured to suit the user's proprietary product needs.

CIRCLE NO. 362

Bus converter joins LSI-11 to Unibus



Able Computer, 1751 Langley Ave., Irvine, CA 92714. (714) 979-7030. From $750; 4 wks.

Qniverter, a dual-purpose bus converter, joins the PDP-11 Unibus to the LSI-11 system. The Unibus gains access to LSI-11-compatible controllers and memories. The board also permits an LSI-11, LSI-11/2, LSI-11/23, PDP-11/03 or PDP-11/23 system to access Unibus-compatible controllers and memories. Qniverter supports many features of the LSI-11/23, including four-level interrupt structure, memory parity and full 256-kbyte addressing. The converter installs into a quad slot of an LSI-11 backplane and is software transparent to its host computer.

CIRCLE NO. 363

Single-card computer controls data-comm

Vantage Data Products, 550 W. 200 S., Suite 8, Provo, UT 84601. (801) 377-6687. $195; stock.

A single-card computer, using a Z80 microprocessor, controls data communications. Asynchronous, RS232 communication is programmable to all standard baud rates to 56 kbits/s. Modem control functions are provided. Sixteen, TTL-level, parallel I/O lines are provided. All inputs include pull-up resistors. Power requirement is 5 and 12 V. Negative voltage for RS232 communication is generated on the card. Options include a software monitor program on EPROM for operation of the computer with a terminal. Another option permits operation from a single 12 to 15 V dc, unregulated power supply.

CIRCLE NO. 364

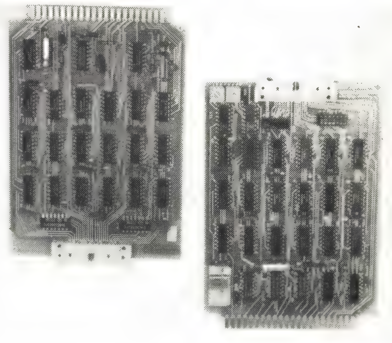
Video board packs graphics and alphanumerics

Lexicon, 60 Turner St., Waltham, MA 02154.(617) 891-6790. P&A: See text.

Lexiscope 4000, a video display controller, adds both graphics and alphanumeric display capability to Data General's Nova or Eclipse series computers. The single board plugs directly into a slot in a Nova or Eclipse mainframe and emulates a standard alphanumeric display terminal. Graphics can thus be added to a system currently using only alphanumeric displays. Separate graphics and alphanumerics cursors and display memory allow independent programming, display and erase. Graphic display resolution is 560 × 500 pixels. In a fixed baud-rate mode, the board emulates such standard terminals as the Data General 6052. In a high-speed mode, the board operates at computer speeds. A FIFO input buffer stores 256 bytes. Alphanumeric capabilities include two pages of 25 × 80 character lines with individual character blink, dim, underscore and reverse video. A 96-character ASCII set is produced.

CIRCLE NO. 365

Control card interfaces steppers/servos to μCs



Advanced Control Systems, 213 Centre St., Quincy, MA 02169. (617) 479-6090. $389.

A dual-board digital motor control, MCB-652-A, works for a computer to regulate speed, direction, position and acceleration of high-speed stepper and dc servo motors. To minimize computer involvement, the boards automatically determine when to decelerate for a given distance. The boards handle stepping rates to 10,000 or up to 100,000 steps/s, distances to 1-million steps and accelerations up to 10,000 or up to 100,000 steps/s^2. A user changes an on-board jumper to select rate and acceleration. The boards measure 4.5 × 6.5 in. and operate from a single 5-V dc supply.

CIRCLE NO. 366

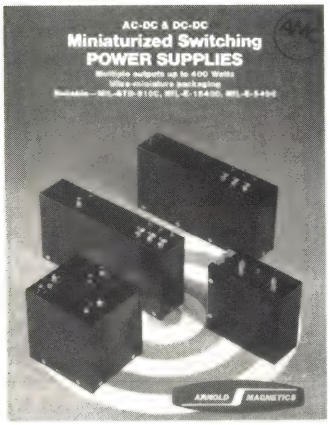
Controller frees processor from data transfer work

Perkin-Elmer Computer Systems, 2 Crescent Pl., Oceanport, NJ 07757.(201) 229-6800. P&A: See text.

An intelligent communications controller, DIOS, provides direct memory access (DMA) facilities between main memory and the firm's hardware communications adapters. With DIOS, data transfers take place without processor intervention, improving system throughput and minimizing processor degradation. Two versions are offered: one accommodating asynchronous protocol, the other for users with concurrent data communications requirements. This version accommodates asynchronous, character synchronous and such bit-protocols as SDLC, HDLC and ADCCP. DIOS supports Bisync protocol, allowing such high-level software as 2780/3780 RJE Emulation and Hasp to operate through DIOS without modification. Data rates to 56 kbaud per line are supported. The first version costs $6000; the second, $7500. Both are available in 8 to 13 wks.

CIRCLE NO. 367

New Literature



AC-DC & DC-DC
Miniaturized Switching
POWER SUPPLIES

Miniature power supplies

Mechanical specs and reliability data on ac/dc and dc/dc miniaturized switching power supplies are given in a 12-page catalog. Arnold Magnetics, Culver City, CA

CIRCLE NO. 368

Wire, cable insulation

Specs, illustrations and applications information on wire and cable, insulation, cordsets and accessories are detailed in a 48-page catalog. Dearborn Wire & Cable, Rosemont, IL

CIRCLE NO. 369

Test chambers

A four-page bulletin outlines a range of benchtop, floor model and walk-in environmental test chambers. Tenney Engineering, Union, NJ

CIRCLE NO. 370

Semiconductor diodes

Tunnel, Schottky-barrier, p-i-n and step-recovery diodes are described in a 52-page brochure. Included are electrical specifications, performance curves, outline drawings and an interchangeability guide, as well as a selection guide for each diode family. Aertech Industries, Sunnyvale, CA

CIRCLE NO. 371

One-part epoxy systems

A four-page brochure describes one-part epoxy resins, adhesives and coatings. Emerson & Cuming, Canton, MA

CIRCLE NO. 372

Silicone products

A 40-page *Guide to Dow Corning Products* summarizes the applications, descriptions and benefits of more than 250 silicone products. Dow Corning, Midland, MI

CIRCLE NO. 373

Teflon sockets

A 16-page catalog describes Teflon sockets and mounting devices for semiconductors, ICs, LEDs and relays. A section on bushings, pads and holders for semis and ICs is included. Sealectro, Mamaroneck, NY

CIRCLE NO. 374

Wire cloth

A 28-page industrial wire cloth catalog covers types of weaves, materials and characteristics. The catalog contains English and metric tables on the physical properties of steel wire and a glossary of terms. National-Standard, Woven Products Div., Corbin, KY

CIRCLE NO. 375

Earth station components

Outline drawings, block diagrams and schematics of satellite earth station components for TVRO terminals and data communications are featured in a 12-page catalog. Merrimac Industries, West Caldwell, NJ

CIRCLE NO. 376

Interconnect systems

Electrical and mechanical specifications of insulation displacement connectors, ribbon cables, bonded cable and bonded twisted pairs, assembly tooling and interconnect assemblies are given in a 24-page catalog. Stanford Applied Engineering, Santa Clara, CA

CIRCLE NO. 377

Components

An 84-page catalog covers industrial linear ICs, consumer ICs, vacuum fluorescent indicator panels, solid tantalum capacitors and discrete semiconductors. Electrical characteristics and packaging specifications are presented and are supported by circuit block diagrams. NEC Electron, Santa Clara, CA

CIRCLE NO. 378

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ABP BPA

(continued from page 155)

Pnp's, npn's, JFETs

Specifications, performance and key parameters of monolithic dual pnp's and npn's and monolithic dual n-channel JFETs are given in a 44-page catalog. Tables and drawings show lead and bonding pad designations and product comparison charts. Micro Power Systems, Santa Clara, CA

CIRCLE NO. 379

Components

A 200-page catalog describes components, posts, jacks, connectors PC plugs and pins, terminals and spacers. English and metric sizes are provided. Concord Electronics, New York, NY

CIRCLE NO. 380

Voltage references

Comprehensive data sheets describe three bandgap voltage references—9491 (1.22 V), 9495 (5 V) 9496 (10 V). Teledyne Semiconductor, Mountain View, CA

CIRCLE NO. 381

Plotter interface

Specifications of the Complot EPIC (electrostatic plotter interface controller) are highlighted in a four-page brochure. Houston Instrument, Austin, TX

CIRCLE NO. 382

Stepper motors

A 32-page stepper-motor guide includes sections on stepper-motor technology, applications and formulas in metric S1. Specifications, torque vs step rate graphs, wiring diagrams and dimensional drawings are shown. Airpax/North American Philips Controls, Cheshire, CT

CIRCLE NO. 383

Design Aids

Darlington transistors

Specifications and characteristics for six npn and three pnp families are given in a wall chart. The chart contains a replacement guide comparing RCA types and devices offered by eight other manufacturers, as well as some limited applications information. RCA Solid State Div.

CIRCLE NO. 384

Waveguides

Over 50 waveguide sizes, from 1 to 300 GHz, are detailed on a wall chart. Aluminum, copper, bronze and silver waveguide electrical and mechanical characteristics are listed with their respective flanges. Waveline.

CIRCLE NO. 385

Specialty lamps

Specialty lamp sizes, base types, filament types and configurations are given on a wall chart. Lamp types include precision xenon and mercury gas-discharge lamps, halogen and opto-electronic exciters. Bulb Technology.

CIRCLE NO. 386

Temperature-EMF tables

An 18-page handbook includes ANSI revised standard tables for all standard thermocouple combinations. Temperature-EMF tables are presented with Fahrenheit and Celsius values. Nanmac Corp.

CIRCLE NO. 387

Nameplate panels

A designer's guide helps engineers to prepare nameplate and faceplate panel specifications. The chart includes information on materials, construction, finishes and textures and performance characteristics. W.H. Brady

CIRCLE NO. 388

Printer specifications

A 5 × 11-in. slide rule presents specifications for medium and high-speed line printers. Letterhead requests only. Digital Associates, 1039 E. Main St., Stamford, CT 06902

INQUIRE DIRECT

IEEE's Young: 'Our mission is career maintenance'

According to president Leo Young, IEEE's principal business is career maintenance for its members, not publishing technology. Interviewed a few days after he took office, Dr. Young said he sees professional activities (pension reforms, patent rights, etc.) evolving as a natural extension of IEEE's historic role as technical publisher, the goal being meaningful lifetime careers for engineers.

Dr. Young was quick to acknowledge the existence of a powerful minority within IEEE that considers the Insitute's "proper" role in terms of technical activities only. However, he said, "it's a mistake to identify issues and people too closely." He considers a compromise better than no progress at all on controversial topics.

Dr. Young believes his petition candidacy and subsequent election bore fruit even before he officially took office. The 1980 U.S. Activities Board budget—approved late in 1979, but after the election results were known—contains more funding for professional activities than the 1979 budget. Yet this new USAB budget was approved by the previous administration, who had consistently played down professional activities before.

Young's plans for 1980, encompass both technical and professional "action areas." He has already approached IEEE's influential 40,000-member computer society to spearhead a campaign to increase cooperation between all of the IEEE technical societies. At the same time, he seeks to make the Technical Activities Board more representational. Right now, each technical society has one member on TAB, regardless of its size. This has been a sore point with the computer society, which has as many as 40 times more members than other IEEE societies.

Where professional activities are concerned, Dr. Young put enactment of a Limited Employees Retirement Account (LERA) at the top of his list. IEEE supports this legislation because it would cover employees, particularly engineers, who never work at one job long enough to vest in any retirement plan already on the books. IEEE is particularly partial to H. R. 628, introduced by California Congressman Jim Corman, and ranks it the best of the LERA bills currently before both houses of Congress.

Model patent agreement calls for comment

The IEEE U.S. Activities Board urges U.S. engineers to comment on a Standard Model Engineering Patent Agreement that could serve as a basis for all individual agreements between engineers and their employers. On December 5, 1979, the USAB voted to circulate its "Proposed Model Agreement Concerning Inventions and Discoveries and Proprietary Information." The USAB document is only a proposal at this point; comments regarding its suitability and suggestions for improvements are needed before the end of April, 1980.

In summary, two main precepts of the USAB proposal contend that:

- An invention belongs to the employee if (1) it was made before the inventor was hired by the employer and (2) it is not included in one of the following (Precept II) categories.
- An invention belongs to the employer if (1) it was conceived by the employee while the employee was performing his or her normal duties or (2) it was financed by the employer and the employee inventor used time, materials, facilities, funds or information supplied by the employer or (3) it is related to activities of the employer and uses information the employee acquired in the course of employment.

The USAB proposal lacks provisions for joint ownership of work-related inventions (employer and engineer/employee) and does not specifically prohibit employers from owning non-work-related inventions.

To obtain a copy of the complete USAB proposed patent agreement and to submit comments on the document, write to Mr. W. Thomas Suttle, c/o IEEE, 1111 Nineteenth St., N.W., Washington, DC 20036; (202) 785-0017.

N.Y. Supreme Court reopens Sperry age case

The New York State Supreme Court has reopened charges of age discrimination against two divisions of the Sperry Rand Corporation. The court granted a petition, filed by the Engineer's Union (Lake Success, NY), that sought annulment of a decision by the New York State Human Rights Appeal Board, dismissing Union-supported charges of age discrimination.

Because of the Supreme Court action, announced Dec. 21, 1979, 62 age-discrimination complaints filed against Sperry in January, 1975, could now be decided on their merits.

The Appeal Board grounded its dismissal (in April, 1979) on the lapse of more than three years since the filing of the original complaints. Based on its interpretation of timeliness as stipulated in the law, the Appeal Board concluded that Sperry was "prejudiced" by the delays.

The Engineer's Union maintains that the time limits applicable to its case are "directory rather than mandatory" and that the determination of protracted delay was not made relative to "the number of complaints, the length of the record or the complexity of the issues."

Although in basic agreement with the Union's position, the Supreme Court opinion states, in part, "While dismissal of the complaints may still be warranted if the Sperry respondents can show that they were substantially prejudiced by the delay, excluding, of course such portions thereof for which they themselves were responsible. . .we cannot make such a determination on this record. Accordingly. . .the Appeal Board is directed to consider the petitioners' appeal on the merits."

Thus, avenues for further appeal and delay now concern the matter of "prejudice," as well as the original case. In assessing the situation, the Engineer's Union attorney Everett Lewis says he does not expect a final resolution anytime soon.

Don Mennie

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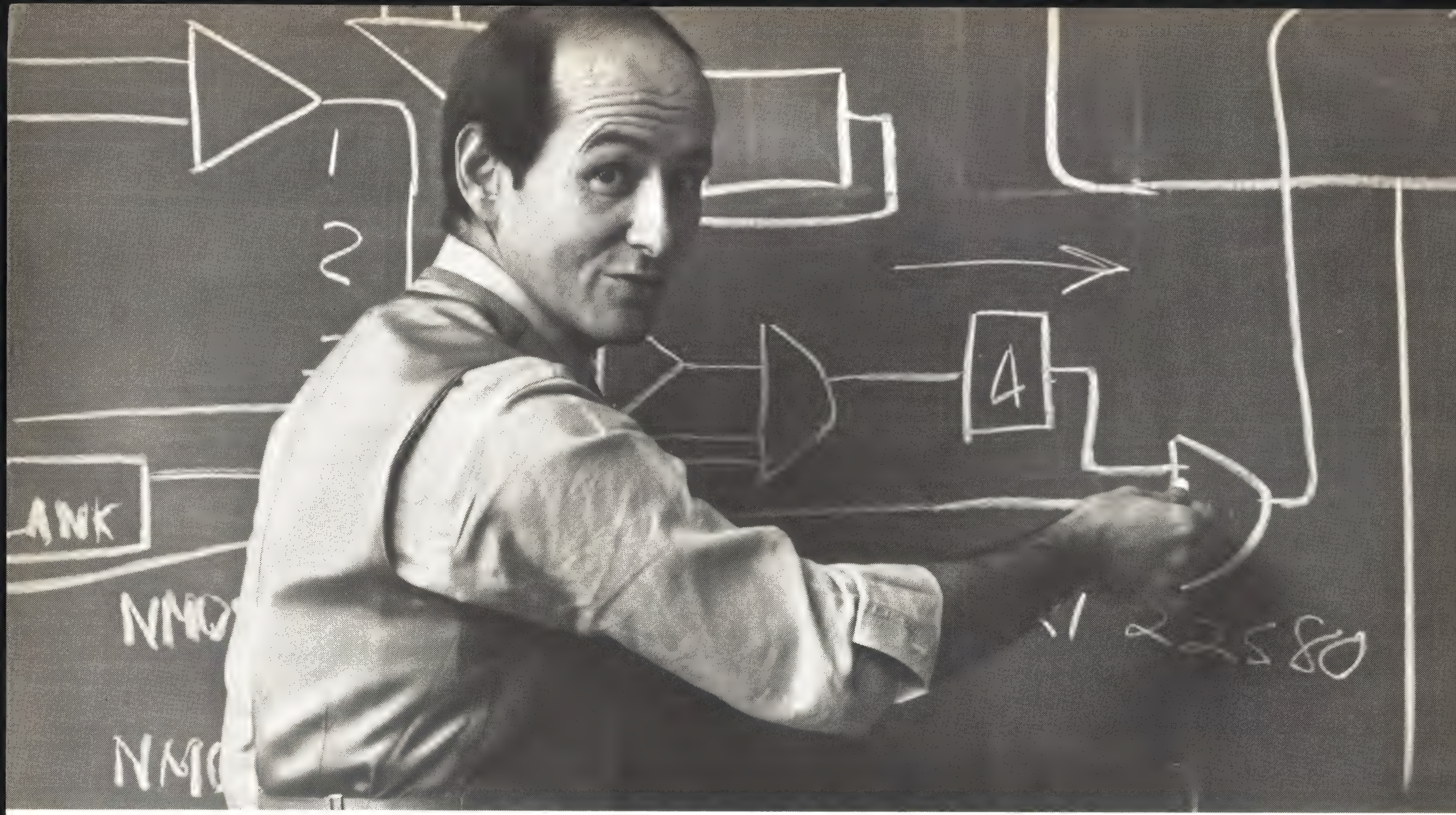

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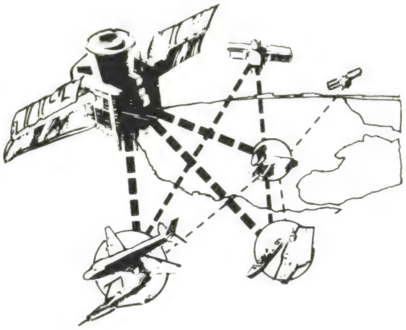

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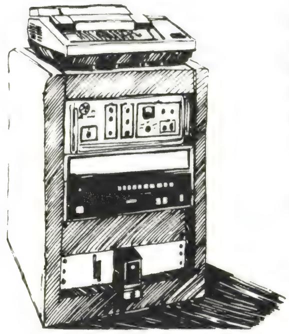

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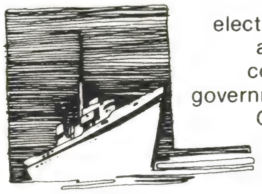

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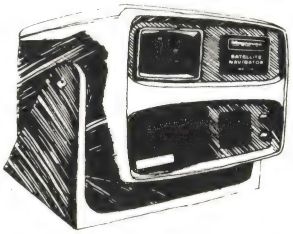

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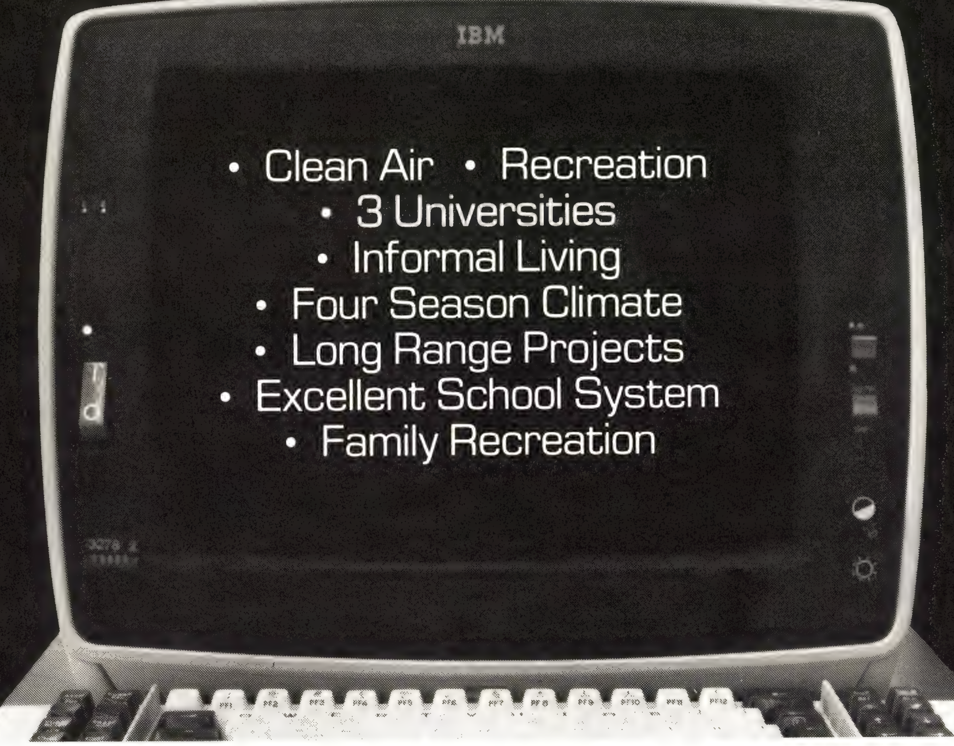

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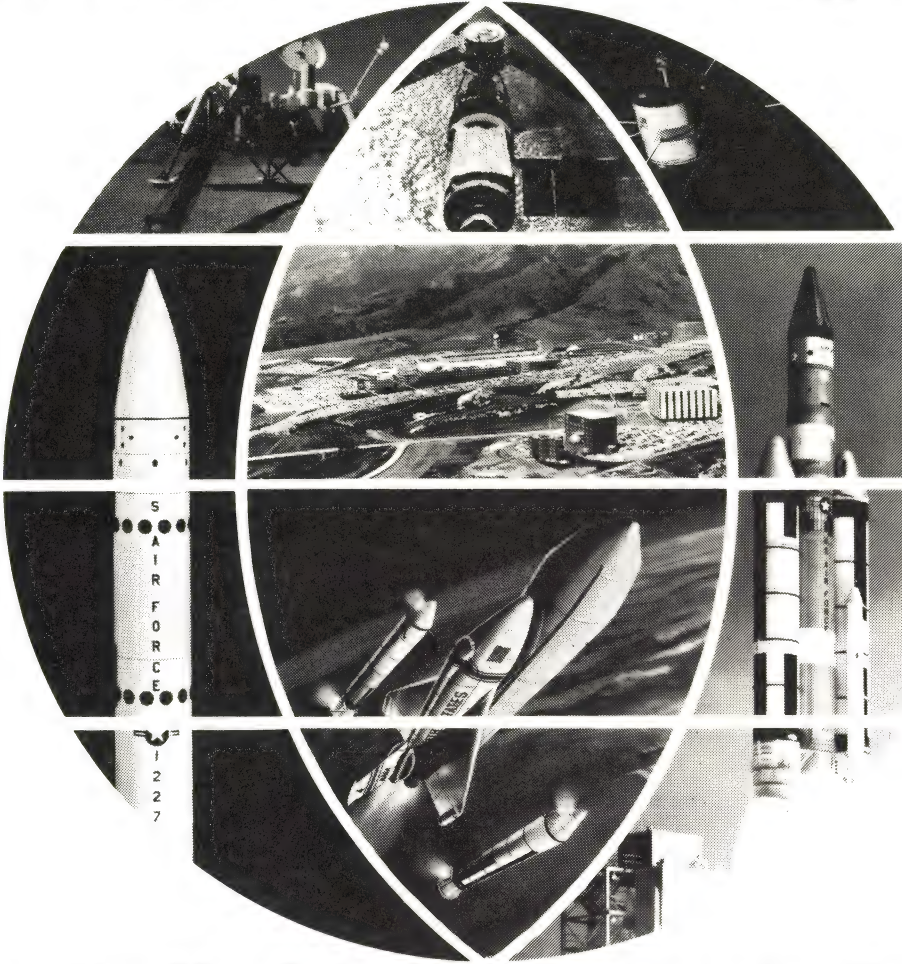

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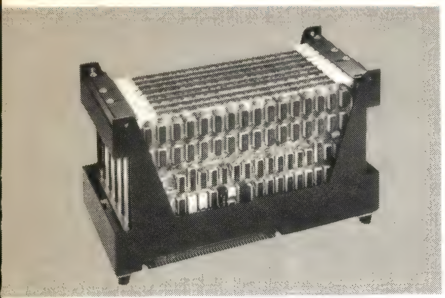

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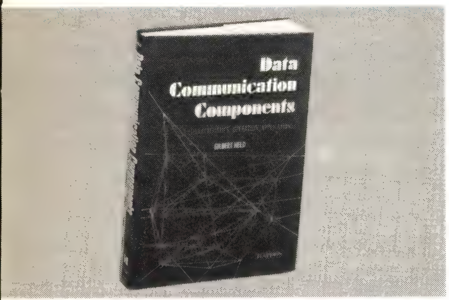

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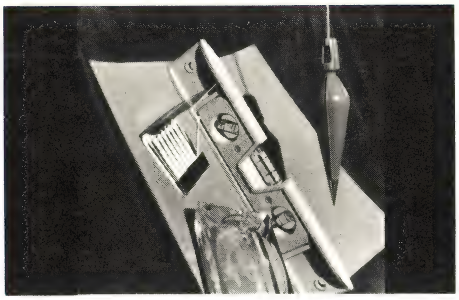

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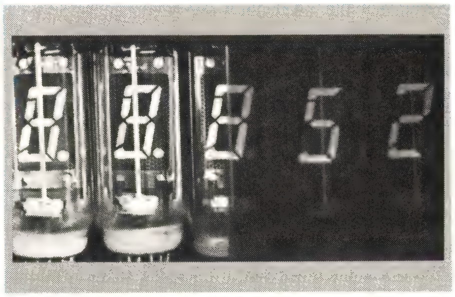

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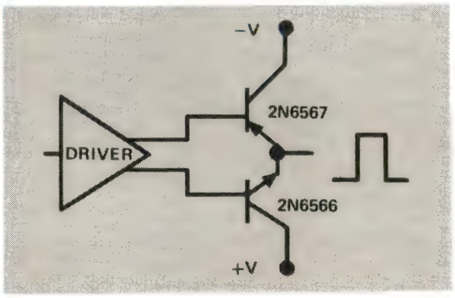

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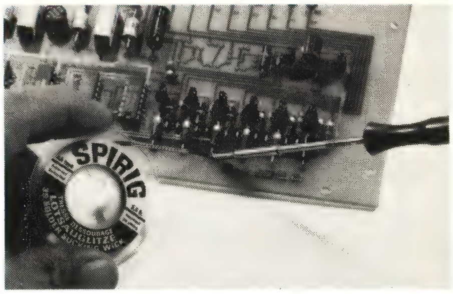

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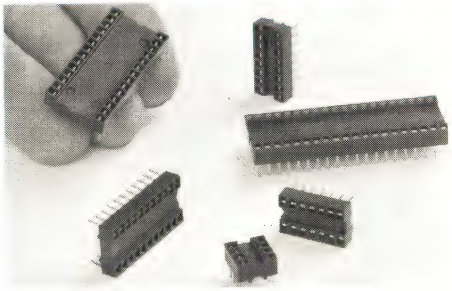

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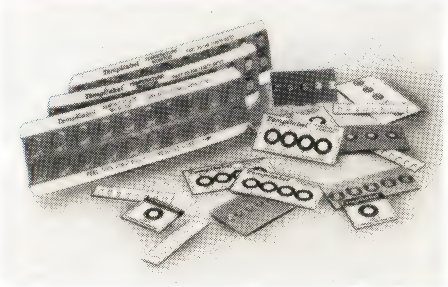

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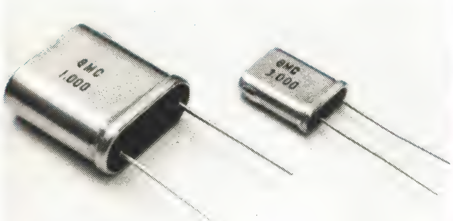

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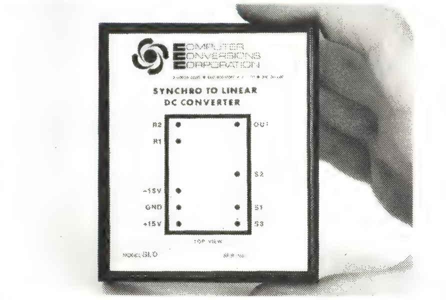
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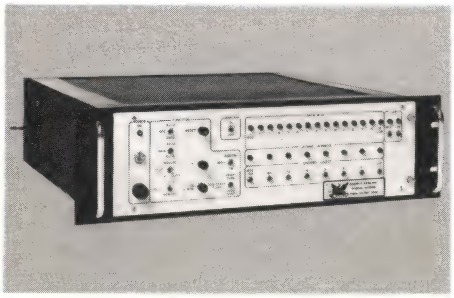

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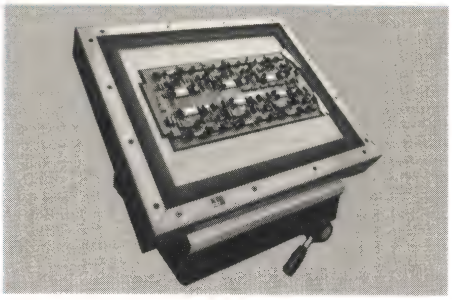

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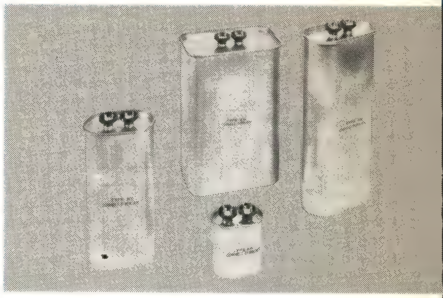

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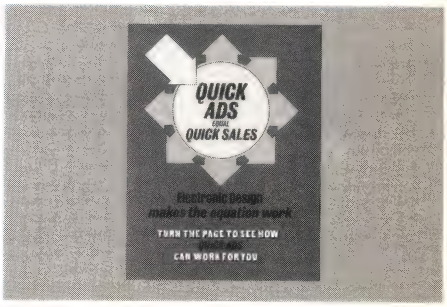

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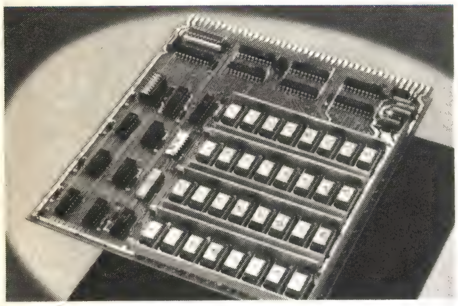

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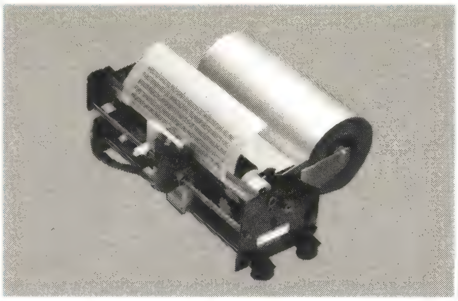

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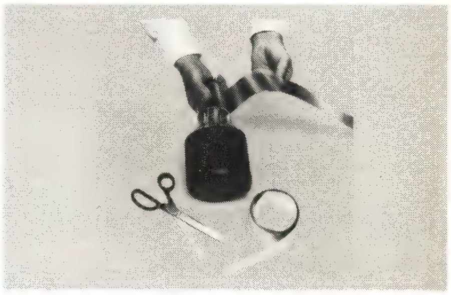

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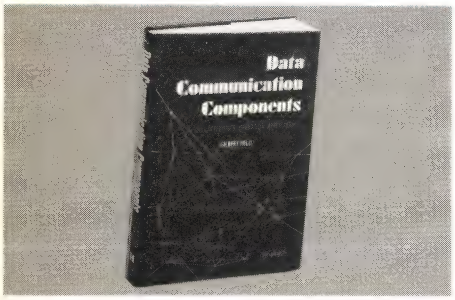

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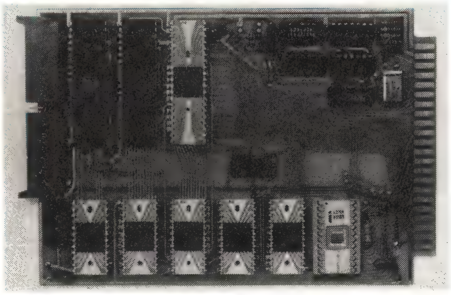

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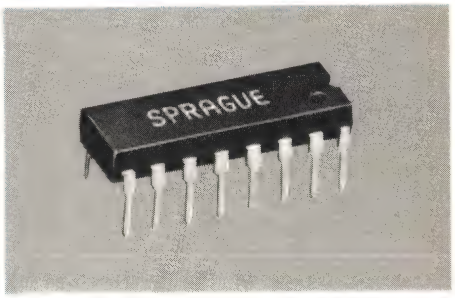

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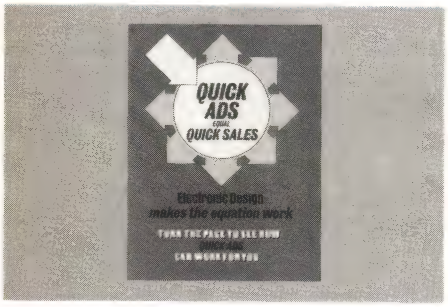

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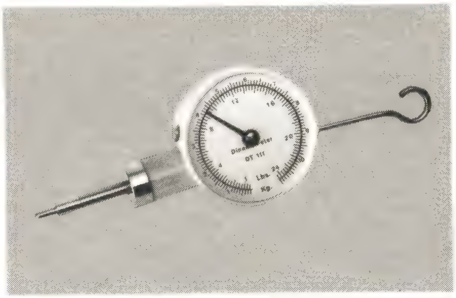

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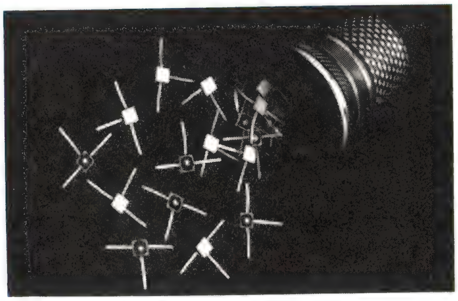

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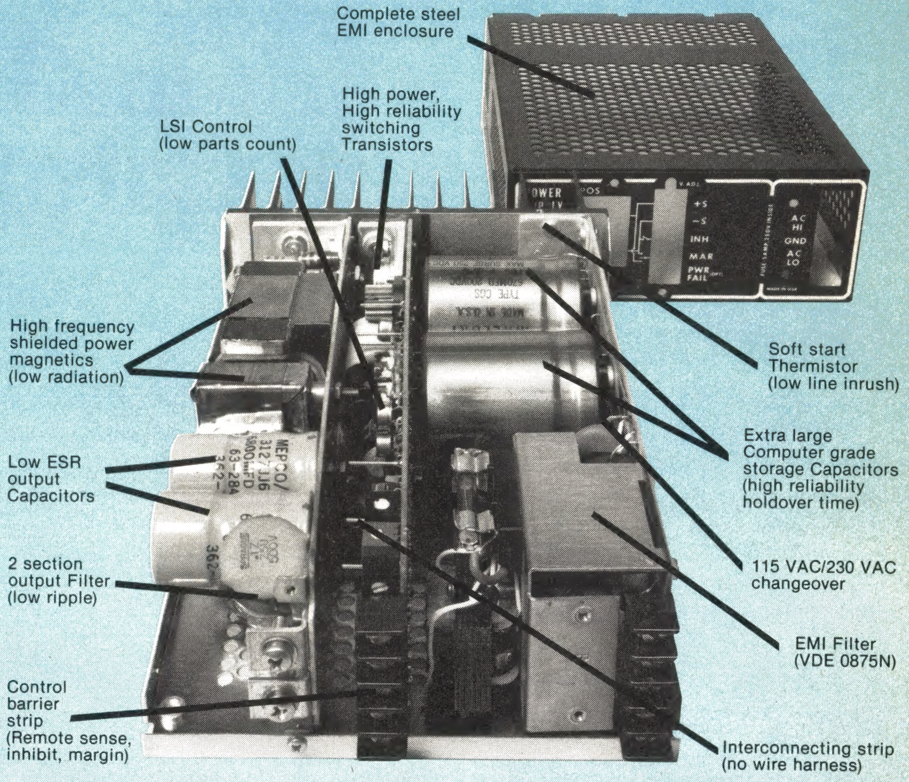
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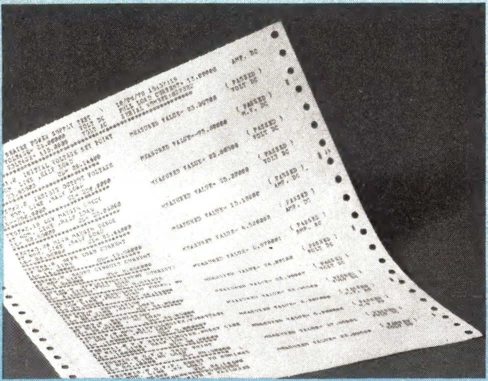

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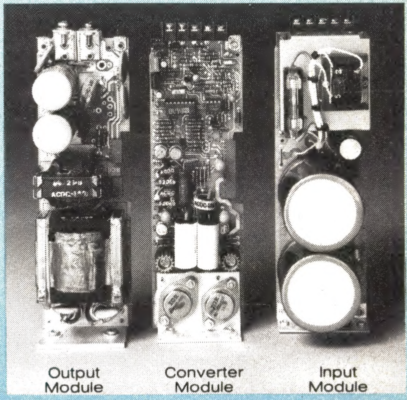

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CASE SIZE	OUTPUT CHARACTERISTICS	VOLTAGE (ADJUSTABLE ± 5%)			
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T10	MAX. CURRENT AMPS	20/2/2	20/2/2	——	——
T15	MAX. CURRENT AMPS	30/5/2	30/4/2	30/5/2	30/4/2
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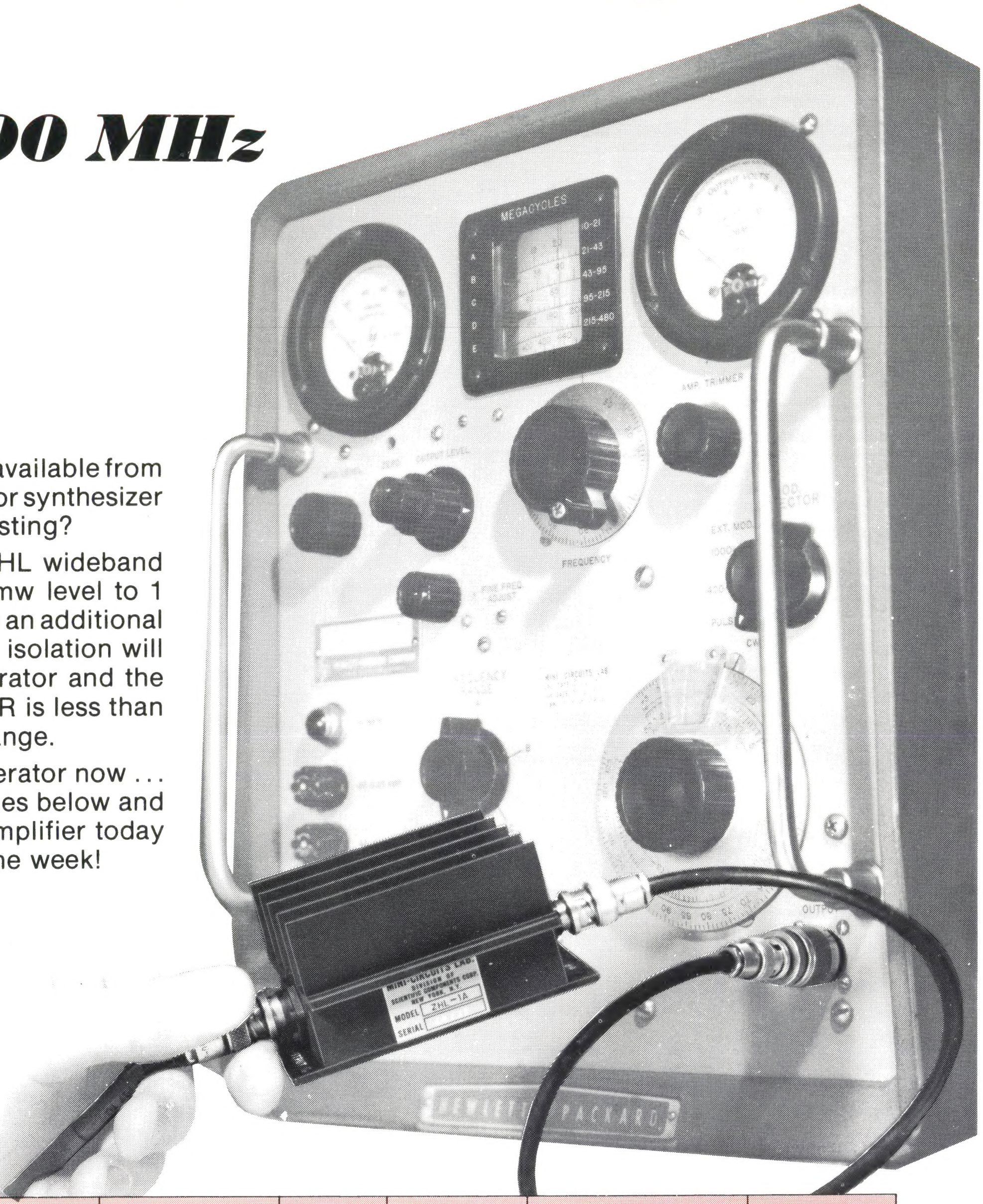

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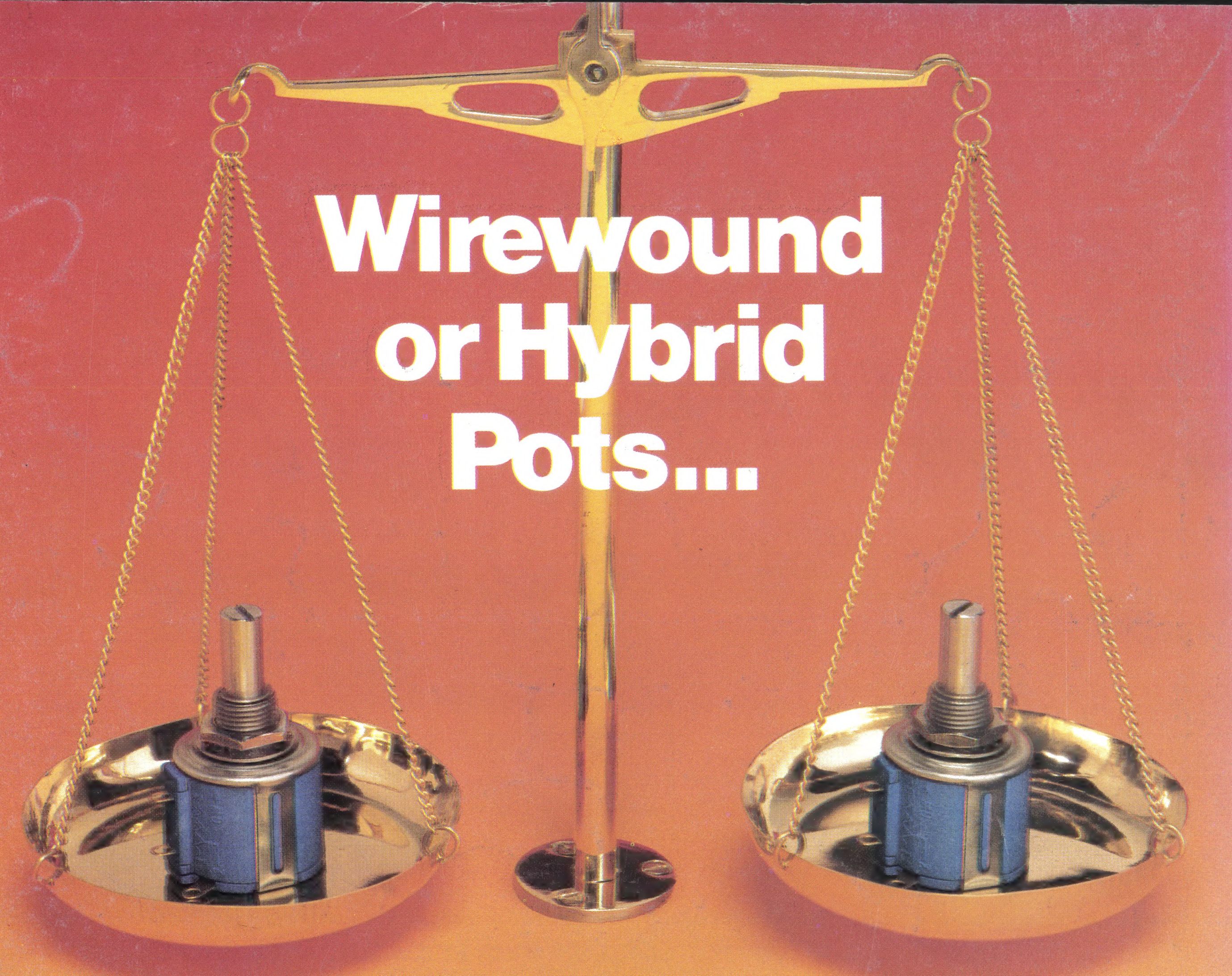

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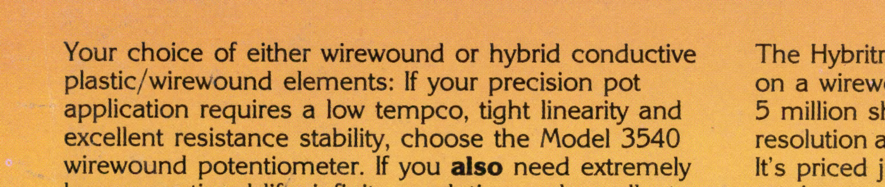

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